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Analysis, Modeling and Improvement of Patient Discharge Process in a Regional Hospital

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Analysis, Modeling and Improvement of Patient Discharge Process in a Regional Hospital

by
Nancy Khurma

A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Industrial and Manufacturing Systems Engineering
In Partial Fulfillment of the Requirements for
the Degree of Master of Applied Science at the
University of Windsor

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2009
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AUTHOR'S DECLARATION OF ORIGINALITY

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ABSTRACT

This thesis presents results of a study conducted jointly with a regional hospital and concerned with the inpatient discharge process. A thorough mapping of the existing process flow and analysis of 1700 historical cases were conducted. Results revealed that in its current form the process is inadequately defined, lacks consistency, and its performance is hard to predict. These issues cause inpatient overstay past their prescribed acute care (so called Alternative Level of Care, or ALC days) and thus at least 8% of available hospital bed capacity is wasted. Key factors extending unnecessary patient stays were identified and used as predictors for individual patients. Another simulation model was created to explore the effects of standardizing parts of the discharge process. Obtained results indicate that organizational changes (e.g., early involvement of social workers, improved information flow, close collaboration with external facilities accepting patients, etc.) will lead to process improvement and substantial economic benefits.

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LIST OF ACRONYMS

ABSDevLOS: Absolute deviation of LOS from ELOS
ADL: Activities of Daily Living Adm: Admission
APACHE: Acute Physiology and Chronic Health Evaluation
Appl: Application Sent
C-Diff: Clostridium Difficile
CCC: Complex Continuing Care
CHT: Canada Health Transfer
CIHI: Canadian Institute of Health Information
CI: Confidence Interval
CMG: Case Mix Group
CRN: Clinical Resource Nurse
D/C: Discharge
DPQ: Discharge Planning Questionnaire
ED: Emergency Department
ELOS: Expected Length of Stay
HDGH: Hotel Dieu Grace Hospital
IADL: Instrumental Activities of Daily Living
InvSW: - Involvement of Social Work
LOS: Length of Stay
LTC: Long Term Care
MRSA: Methicillin Resistant Staphylococcus Aureus
NEU: Neurological Unit
NSF: National Service Framework
NSX: Neurosurgical Unit
OPR: Operating Room
OT: Occupational Therapist
PACU: Post Anaesthetic Unit
PIP: Patient in Process
PT: Physiotherapist
QFD: Quality Function Deployment
RefSW : Referral to Social Work
RIE: Rapid Improvement Event
RN: Registered Nurse
RPN: Registered Practical Nurse
RYG-Light: Red, Yellow, Green Light Initiative
TBM: Time Based Management
TEL: Telemetry Unit
TPOC: Transformation Plan of Care
VRE: Vancomycin Resistant Enterococcus
VSM: Value Stream Mapping
WIP: Work in Process

CHAPTER 1: INTRODUCTION

1.1. General Overview

1.1.1. The Healthcare System - Recent Trends

People require healthcare services from the moment they are born, and the demand for those services varies during their life time, therefore the volume of demand is almost the size of the human population. The complex nature of the human body and the potential ailments it might suffer add to the complexity of what is expected from healthcare service providers.

A healthcare system can be defined as a set of facilities and organizations that participate in providing services that relate to individuals' health and wellbeing. The structure and functioning of the healthcare system is largely shaped by the country or territory it is serving.

In Canada, the healthcare system is an “interlocking set of provincial and three territorial health insurance plans,” and services are provided as necessary to all citizens without direct pay. Physicians, hospitals, clinics, long term care facilities, rehab centers, etc., deliver whatever it is that the patient needs [1]. The publicly funded healthcare system is claimed to reflect the nation's beliefs of equality and complete accessibility. Canada's national health insurance program (Medicare) is responsible for that universal access to healthcare services across the country [2]. The 13 provincial and territorial plans have

common coverage features and standards and together form a national program. These plans are funded through a federal cash contribution under the Canada Health Transfer (CHT). Qualifying to receive their maximum share requires compliance with the federal health insurance legislation, criteria and conditions. According to Health Canada, Canada Health Act is “Canada’s federal legislation for publicly funded healthcare insurance.” It is this act that dictates the criteria and conditions that each plan must account for [3].

Typically, Canadians seek primary care as a first step in trying to solve their health problems. Very often, individuals receive their proper diagnosis and treatment (or intervention) and have their medical or health concern taken care of. While they come at the front line of the system, this step also includes; doctors, nurses, pharmacists, and therapists among many others. When found necessary, patients are passed on to specialised hospitals, long term care facilities or home care services [4].

The Canadian healthcare system has been and is still experiencing immense pressure due to “changes in the way services are delivered, fiscal constraints, the aging of the baby boom generation and the high cost of new technology”[4]; factors that will not recede anytime soon. Possibly seen as a way to alleviate some of that pressure, the Canadian healthcare system follows a trend of encouraging the reliance on “clinics, primary healthcare centres, community health centres and home care; treatment using medical equipment and drugs; and public health interventions” [4]. Accordingly, Health Canada has reported a decrease of 10% in the number of nights spent in acute care at hospitals, along with a decrease in the number of hospitals themselves. Rationally, advances in technology and increases in minimally invasive procedures have contributed to shortening

acute care requirements. Canadian healthcare spending rose from 7% to 10.4% of the Gross Domestic Product from the year 1975 to 2005. During the same period a significant share of expenditures has dropped from physicians and hospitals, but rose for prescription drugs. Waiting time issues for accessing healthcare services have surfaced with studies carried out in the 1990's [5]. However only in 2004 did Health Canada report initiating a plan to improve "access to quality care and reducing wait times" in a 10-Year Plan to Strengthen Healthcare [4].

1.1.2. Industrial Engineering in Healthcare

Healthcare facilities are most generally places where services are being provided to customers utilizing material and equipment by a team of professionals. This sounds very similar to any facility or organization in any given industry. Keeping track of the quality of service being delivered to the patient requires quality management and control tools. Ensuring the ability to respond to patients needs on time while maintaining the lowest possible cost, calls for optimization tools. Implementing changes in such a sensitive environment that can never be paused or put to a halt, are extremely challenging. Therefore, having the ability to test and evaluate those changes before confirming their feasibility require the deployment of simulation tools. All of these and more are in the industrial engineering discipline toolbox.

The modeling concept is one of the key characteristics of approaching problems in industrial engineering. Several types of models exist and each of them targets different outputs [6]. Project Management models are the ones that help manage large projects with

many activities that occur sequentially, dependently or independently [7]. The list of activities to complete a project is defined with their expected duration and cost. Using the critical path method and the project evaluation and review technique, the paths that lead most efficiently to the finishing point of the project are identified. The strict timeliness of critical paths is highlighted, while the tolerances than can be afforded in other paths also appear.

Healthcare reform is a term that has frequently been mentioned by United States and Canadian governments as a promise to the public that efforts have been, are being, and will be spent to improve the performance of healthcare delivery. Hospitals form a large part of the healthcare sector, which means they are going subjects of an equally large share of that reform. Reform can be another way of saying ‘changing for the better,’ and individuals working in this sector should know that change requires effort and commitment. While changes on such a large scale are being planned, they will be carried out through different sized projects. Hence, project management can be one of the tools in bringing about this reform.

Another modeling technique that can be used is statistical modeling which includes regression analysis, design of experiments, and quality control under its umbrella [7]. This avenue is usually meaningful after relevant data collection takes place. Outputs of this model can produce very powerful metrics that can be used for direct decision making, or as input to other equally influential modelling techniques. Statistical Analyses are widely used in both engineering and healthcare disciplines, process performance can be

described by its measured statistical parameters (such as means, medians, variances and probability distributions). Only after the thorough understanding of those parameters a meaningful intervention can be introduced to the process to improve its characteristics. Very often, changing a process variable causes a change in many other dependent variables. This might work to the benefit of the intended intervention or vice versa. In these particular situations, statistical correlation and regression (linear, non-linear or logistic) become very feasible. Regression can be applied in healthcare to predict - for example - how long a patient may remain ill, and determine which variables contribute most to this length of time [8]. If, for example, it turns out that invasive surgeries cause prolonged states of weakness or poor recovery, then efforts will be directed towards this matter to help design tools for minimally invasive surgeries.

Statistical tools can be useful in identifying probability distribution parameters that are used as inputs in simulation modeling. A large body of research literature exists on the applications of simulation in healthcare. The approach can be used in scheduling hospital operations, allocating resources, predicting admissions, studying risk-management, and many others.

Value stream mapping is a method that models all the steps of the process from start to finish. The map is described as one that “captures processes, material flows and information flows of a given product family and helps to identify waste in the system” [9]. In modifying what has been said to a service sector industry, and in particular the healthcare industry, the map would have to capture all the elements of the processes,

material flows and information flows of a given patient group to identify which of them add value to the process and which do not. Value stream maps and patient flow process modeling can be the patient-centered way of observing process mechanisms. Table 1 lists a summary of examples of industrial engineering tools used in manufacturing and healthcare applications, along with possible similarities and differences.

The following section will converge in relevance to the research focus in explaining what is meant by ‘discharge’ in the healthcare industry, and how it can be identified as a process just like processes in manufacturing and service industries. Being a process, discharging a patient involves several steps which will be briefly mentioned in this section, along with the introduction of the term discharge planning.

1.1.3. Discharge and Discharge Planning

In manufacturing industries, the output in rough terms is usually considered to be equivalent to the final product. However, that is not entirely comprehensive; the final product does not resemble the completion of the manufacturing process. In some common cases, the product might still need to be packaged, inspected, have some instruction manuals added to it, and have the most suitable routes and transportation modes prepared for delivery. Numerous software solutions, technologies and optimization models have been created to alleviate the complexity of these activities that come after the completion of the final product. The effort and resources put to this service cannot be separated when measuring the organization’s performance.

Table 1: Examples of Industrial Engineering Tools in Manufacturing and Healthcare

Tool	Manufacturing Application Example	Healthcare Application Example	Similarities / Differences
Project Management	Managing the construction of a warehouse	Managing a healthcare reform project	Similar techniques used to keep the work within time and budget constraints. Different in that some healthcare improvement projects have to be run in a way the system is not put to a halt.
Simulation Modeling	Simulating a production line	Simulating patient flow	In healthcare systems there is usually large variation due to unpredictable human behaviour, and wide range of provided services.
Optimization modeling	Creating the optimal network for distributing goods	Optimizing the usage of operating rooms	Similar in the sense of defining an objective to be accomplished within certain constraints, however the nature of the healthcare environment is challenging due to the occurrence of emergencies.
Quality Control	Keeping a certain product size within specified dimensions.	Maintaining air quality of hospital operating rooms	Quality control in healthcare tends to be less tolerant due to the criticality of the patient's well-being
Statistical Analysis	Contributors to better customer satisfaction	Contributors to length of stay at a hospital	Factor analysis can be similar in both disciplines.
Value stream mapping	Mapping the process of assembling an engine	Mapping the process of patients going through ED	In both disciplines, value added verses none value added elements will be highlighted. In healthcare some services are still not done as standard work and the VSM might not be representative of all cases.

Now moving to the healthcare industry, and precisely to the delivery of care in hospitals, one may in rough terms associate between the act of improving the patient's health or curing their ailment with the act of completing the final product in a manufacturing industry. Yet in this case as well, a lot needs to be done to get the patient out of the system i.e., to leave the hospital. It goes beyond the activities completed done within the treatment phase.

“An “inpatient” is a person who has been admitted to a hospital for bed occupancy for purposes of receiving inpatient hospital services. A person is considered an inpatient if formally admitted as an inpatient with the expectation of remaining at least overnight and occupying a bed, even if it later develops that discharge or transfer to another hospital is possible and a hospital bed actually is not used overnight” [10]. In the simplest form possible, and for any inpatient, their total hospital experience can be divided described into three distinct phases; admission, intervention, and discharge. Even though they occur in that sequence, these phases do tend to overlap.

Within each phase come many administrative, medical, clinical and psychological aspects that have to be achieved to complete patient care. Focusing on the end of a patient's episode, one recognizes that it finishes with the patient leaving the hospital. The very final step in that would include having a porter or a nurse accompany the patient outside the hospital door.

In between the completion of the intervention or treatment stage of the hospital stay and the time when the patient is actually leaving the hospital, several procedures have to take

place, by engaging various staff members. And in linking back to manufacturing industries, the inspection here can be seen as the assessments carried out by a physician, social worker and other allied healthcare professionals to clear the patient for discharge. Things like instructional manuals could be translated here as a sheet that is filled out and given to the patient containing physician's orders, prescriptions, and case specific post-discharge instructions. When properly and accurately defined, processes in all industries can be studied and evaluated utilizing familiar methods. This allows for the discovery of flaws, complexities and inefficiencies. It allows for assessment and modification. The establishment of process standards also facilitates consistency, efficiency and accuracy. Continuous monitoring of the process is always essential in staying on the right track, despite changing demand and other key variables. Therefore, identifying patient discharge as a process and completely understanding how it is being accomplished exposes all those characteristics and improvement opportunities.

Healthcare practitioners have come up with a concept that aims to organize the different tasks performed under the discharge process with the objective of allowing it to flow more smoothly. It is referred to as 'discharge planning', defined as "... an ongoing process that facilitates the discharge of the patient to the appropriate level of care. It involves a multidisciplinary assessment of patient/family needs and coordination of care, services and referrals" [11]. The creation of a plan relies greatly on communication between the nurses, physician, patient, family, other healthcare professionals and any necessary long-term care facilities.

In studying the discharge process, through observation, staff meetings and data collection, this thesis was completed with substantial collaboration and support from management and staff of Hotel Dieu Grace Hospital (HDGH) in Windsor, Ontario. The following section will provide a general of the hospital.

1.2. About the Hospital

“Hotel Dieu Grace Hospital (HDGH) is the region’s premier tertiary acute care hospital, ... providing state of the art diagnostic imaging technology and leading in areas of complex trauma, neural diagnosis, acute mental health, cardiac care, stroke and neurosurgical, and the broad foundation of medical and surgical services required to support these areas” [12].

Working with 412 physicians, the hospital operates 305 patient beds; 128 in Medicine, 84 in Surgery, 20 in Intensive Care Unit, 9 in Cardiac Care Unit, and 64 in Mental Health Unit. They provide care to an average of 120,000 patients per year, conducting 158,960 diagnostic exams and 8,705 nuclear medicine tests per year [13].

HDGH management feels the need to improve hospital processes and operations in order to overcome capacity issues the hospital is currently facing. They fear of what will come in the future, which has been described as “a patient tsunami.” The management took the avenue of Lean and Flo initiatives in hopes to move forward. HDGH’s ultimate goal is a so-called Transformation Plan of Care (TPOC) that will build needed capacity throughout the entire organization. On the path to this transformation, small size lean projects

targeting micro-goals have been conducted. These efforts are until now isolated from each other and the hospital faces a challenge in combining them together, putting everyone on board, and significantly elevating the performance of the organization altogether.

Management concluded that the initial state includes frustrated staff and physicians who are finding it increasingly more difficult to meet all the patients' needs. The hospital revenues seem not to be keeping up with the expenses and some physicians are leaving the organization. There seems to be lack of a clear vision of what is expected of this organization as a whole. While separate departments say that they are doing the best that they can, this is somehow not achieving the best for the hospital overall [14].

The management is trying to fight all those problems by engaging all personnel to improve processes across the hospital. The value stream mapping approach is used as a common tool to understand what is going on and create better connections between processes. The need for having someone directly responsible for leading these activities is emphasized. General metrics that the hospital looks at when measuring its own performance are:

- length of stay
- mortality ratio
- occupancy rates
- patient satisfaction
- staff satisfaction

- net operating margin [14]

According to the data collected by the hospital, occupancy rates, emergency room wait times and numbers of cancelled elective surgeries have all increased since 2005 [15]. HDGH identified its strategic planning structure clearly. In the operation strategy four strategic priorities are outlined and the top one is to achieve smooth flow. The flow dictates the speed at which patients transition through the stages of their hospital experience. Smooth flow would be achieved if congestions or bottlenecks do not occur at any of those stages, and delays would be minimal. With smoother and faster flow, demand at the admissions department can be met more efficiently and the work load would be balanced among hospital departments.

The expected outcomes of HDGH strategic planning are to maximize patient access and flow to best meet the needs of patients and their families. The year 2008 was divided into four periods, and in the first period an operating objective was to map medical and surgical patient flow value streams. The second was to demonstrate clarified problem areas and set a target improvement state. It also was to engage physicians and develop a process to sustain improvements [16]. The third period's operating objectives included:

- Improving the discharge process
- Spreading a discharge planning initiative that was introduced to one of the medical in-patient units that year
- Clarifying accountabilities for timely discharge.

Some of the other strategic goals that came under smooth flow were:

- Building hospital wide capacity to respond to the growing and changing demand for healthcare services in the community. That includes achieving improvements in metrics such as emergency room wait times, cancelled elective surgeries, and discharge times.
- Optimizing opportunities for meaningful partnerships and regional integration.

The HDGH management identified three main value streams flowing in the hospital. The first one is Patient Flow, which is the common process any patient goes through from admission to discharge. The second is Information Flow, which involves the clinical and administrative activities that document the care provided. The last is Ancillary Processes Flow, which pertains to procedures based on patient needs.

In trying to get more and more employees on board the planned transformation, management and lean facilitators are conducting three short improvement events per month. New issues appear from each event that were not included in the defined scope of the original events, but are put aside to become the title for the next improvement event. Three weeks before the occurrence of the rapid improvement event (RIE), a committee reviews the issues that are set on the table, decides is going to be selected to participate in this particular event, and prepares the data necessary to provide the complete picture of the current situation at the start of the event. When the scheduled date of the event comes, participants are invited to gather for 5 days to:

- Identify the problems through mapping, discussion and observation.

- Suggest causes and brainstorm for improvement ideas.
- Rank ideas according to impact and attainability (within those 5 days).
- Select the appropriate ideas.
- Implement ideas in day-long experiments while collecting indicative metrics.
- Standardize the shape of those changes for consistency and sustainability purposes.
- Present a summary to what has been done to the rest of the hospital.

Leaders of the improvement teams are responsible for following up with how the changes are being implemented after the event, and measuring their impact for the next three months. Two examples of previous events are; ‘standardizing the bed cleaning (turnover) process’ and ‘reducing cost of operation room supplies’. For the first example, bed turnover time was reduced from an average of 60 to 40 minutes and, and for the second, a savings of \$37,000 was achieved after 3 months.

At each of those events, the hospital educated the new participants about the tools that are used in this improvement process. Almost part of every hospital employee job description includes participating in quality improvement activities. Participants are instructed about the various wastes that are occurring in healthcare (the 8 Wastes concept from Six Sigma: overproduction, transportation, defects, waiting, over processing, unnecessary motion, inventory, and unused human potential). Participants are also told of the hospital’s ambitions of achieving a cultural change throughout the entire organization by

introducing the need to think beyond the care itself; to increase awareness about efficiency and quality of care.

1.3. Problem Definition

Technological advances enabled treating patients for ailments that were considered to be terminal in the past. This phenomenon increased discharge planning complexities in particular for older patients with multiple conditions. Due to shortened treatment procedure times, the time patients spent at the hospital are also shorter [17]. As a result, nurses now have shorter windows of opportunity to get to know the patients and their needs that are critical for discharge planning [18]. The increased demand for hospital beds is overwhelming, and freeing-up inpatient beds is a top priority. Therefore, delays in discharge planning and unsynchronized patient flows are not tolerable.

In HDGH the broader issue is the inability to place the patients in the right bed (e.g. in the proper care unit) at the first attempt. The reason for that is mainly the unavailability of beds. The admission clerk is forced to place emergency admissions in less appropriate beds but available and then transfer them whenever it becomes possible. Other issues that are caused by the unavailability of beds are delays and cancellations of elective surgeries. Numerous effects are caused by these unfortunate incidences, including reduced quality of care, reduced patient satisfaction, susceptibility of deterioration in patients' conditions, lost revenues due to cancelled surgeries, and many more.

Several practical and theoretical attempts have focused on the length-of-stay (LOS) metric. Reducing LOS is commonly believed to increase capacity, improve turnover rate and enable meeting a better portion of demand sooner. A phase in the patient episode that is thought to contribute to decreasing LOS is the discharge planning phase.

The results of an improvement event that was designed to discuss admission conditions, unaccountably was steered towards discussing patient flow and discharge. Out of 34 ideas which were brought mentioned in the brainstorming session, 13 were related to the discharge process, even though the focus of the event was elsewhere. A wide range of healthcare professionals are involved in the discharge process. The decisions are not only made by them, but also by the patients and sometimes their family members. This phenomenon describes how complex this process might be. Due to such a complex nature, there is a challenge in predicting accurate information regarding the status of beds, in terms of the number of leaving patients. The admitting department is supposed to work with those predictions in preparing the admissions of that day. Less accurate information will aggravate the problems that are already occurring at the admission end from delays, and transfers to cancellations. This reinforces the previous arguments in describing the need for directing focus on the discharge process.

Within the focus of this thesis reside three main problems:

1. Planning for admissions from discharge information; which is the planning carried out to synchronize admissions according to expected discharges. The focus of many research efforts were directed towards the front end of the process in trying to improve its performance. However, not as many did so by regulating and

improving the very end of the patients' episodes even though this is what dictates the periodic freed up capacity for admissions. The problems in HDGH that are related to this issue are explained in the following points:

- a. There is lack of understanding in the sequence and structure of the discharge process, which results in: lack of consistency, hidden inefficiencies, and difficulty in analysing and improving the process.
- b. The hospital relies on nurse expectations in predicting day by day discharges. The predictions are done in the morning of the same day, and it was observed that they are not sufficiently accurate for making solid decisions, consequently creating a mismatch between admissions and discharges.
- c. A metric that the hospital generates for each inpatient is the expected length of stay (ELOS); yet another parameter that should be able to predict discharge time, and create a match between LOS and the freed up capacity. It has been detected that the ELOS and actual LOS for any amount of patients deviate considerably.

2. The second problem lies in the discharge process delays within each patient episode. Delays that occur in the discharge planning are believed to be treatable to some extent. The main discharge delay that this thesis project aimed to analyse and understand is the number of Alternate Level of Care (ALC) days as there is limited discovery of the factors affecting or contributing to ALC days throughout Canadian hospitals in general and to HDGH in particular. When looked at from a high end, this delay can have two general contributing parts: (i) delays in acute care hospital operations, and (ii) delays due to unavailability of resources (beds,

nurses, equipment) in the receiving continuing care facility. For the first part, the paper aims to understand the steps in the discharge process and how they could be modified to reduce ALC days or LOS.

3. An initiative was introduced to help alleviate discharge planning problems called the Red light-Yellow light- Green light Initiative. Though it is a visual strategy, it is thought to influence quantitative matters. One of the goals of this initiative was to reduce ALC days. The questions to be answered here are: how successful is the initiative in serving its purpose? And did it help reduce ALC days or not?

CHAPTER 2: LITERATURE REVIEW

This chapter will review literature that emphasized the need for identifying delays occurring in hospitals that impede patient flow. With relevance to inpatient units, it will introduce some of what has been said and done in terms of discharge planning. It declares the call for recuperating this aspect of the patient's hospital experience as an effort that partakes in improving patient flow. Finally, research efforts that tackled the same issues using modelling techniques and tools used in industrial engineering will be referenced.

2.1. Patient Flow and Throughput

Hospitals are experiencing ongoing pressure to provide satisfactory care and the resources involved are having trouble realizing expectations. Researchers did not only go after the reasons for this increase in pressure, as they know that parts of it go back to the root changes in the nation's population's health status. However, a special effort was spent in studying all sorts of delays that are occurring in hospitals based on observation [19]. The delays were categorized into 9 major and 166 minor categories. This organized classification was suggested to act as what was called "the delay tool". The tool was designed to be general enough to accommodate all hospitals, yet detailed enough to extract the reasons for inefficiencies. It was meant to be affordable and simple to learn and use. By utilizing it, the study suggests that time-wise feasible real-time assessments can be done that will bring to light the delays and inefficiencies occurring in a particular process at a hospital. When the delay tool was put in operation on general internal

medicine and gastrointestinal services for 6 months, it found that “30% of 960 patients experienced delays” each averaging to 2.9 days. The study also showed that most delays occurred in the following frequency [19]:

- Scheduling of tests (31%).
- Unavailability of post-discharge facilities (21%).
- Physician decision-making (13%).
- Discharge planning (12%).
- Scheduling of surgery (12%).

However, when defined in terms of delay days, and due to the length of the delays, awaiting post-discharge facilities was found to cause 41% of them, hence being the most important problem [19]. Even though this study proposes an indicative tool that can highlight and quantify delays, it admits that the delay tool’s abilities stop there, and further efforts, tools and analyses should be carried out to decide on optimal courses of action.

Another attempt to improve the efficiency of patient flow was conducted in Lucile Packard Children’s hospital in California [20]. The hospital faced many problems when it had to delay and turn away patients due to the lack of capacity. The flow was defined from admission through discharge and all the steps were laid down for the purpose of re-engineering the process. The objective was to “achieve lasting performance improvement”. The effort was directed to measure the effectiveness and improve the following areas:

- Reducing patient placement delays.
- Decreasing diversion volumes and understanding causes.
- Improving accuracy of bed availability and admission predictions.
- Reducing the number of medically unnecessary patient days and payment denials.
- Decreasing the frequency of discharge delays.
- Improving bed turnaround time.
- Enhancing the consistency of care performance.
- Reducing variances from established standards of care.

To bring about those improvements, distinct measures were set that became standards of performance. Continuously, the goal was to increase care and service coordination, create and sustain cultural change and redefine staff job functions. To be able to track what has been done throughout each week, reports were created about patient admission, bed assignments, delayed discharge and bed turnaround among others. Meetings specially conducted for evaluation of patient flow performance were carried out, and most of what is discussed there is fed by that week's report. In redefining staffing and job functions, the study suggested modifying the nursing supervisor position such that they are capable of making appropriate decisions in bed assignment and staffing based on their solid clinical knowledge. They suggest that the nurse supervisor should be able to manage and organize situations such as at peak demand levels, and to encourage case managers to be more involved and active in facilitating the discharge planning process. The results of creating those measures and redefining job responsibilities showed a 40% increase in the ability to anticipate patient discharge. Medical residents collaborated in improving predictability by

effectively completing patient rounds and patient discharge orders [20]. This paper brought general promising ideas that might be applicable in many other hospitals, though it did not mention the tools that were used to implement those challenging changes.

Instead of redefining roles under the different job descriptions, a new job position altogether was a later modification in efforts to smoothen patient flow. The need to investigate more solutions allowed the emergence of the bed management concept [21]. For that, the Bed Manager title was given to a nurse that practices the identification of empty beds and allocation of waiting patients to them. In many cases, the admission clerk implements that role, though not in a comprehensive manner. Admission clerks are informed about empty beds, and they assign new patients to them, rather than active personnel in identifying those empty beds. The process of bed management is shown in Figure 1 [21].

The research effort did not explicitly imply the effects of having bed managers on board, but rather was more concerned about the training that they should receive in order to be accountable and pro-active bed managers.

A fundamental portion of the bed management process is communication. As shown in Figure 1 above, arrows are connecting this duty with all the stages for any patient case. To communicate information about numbers of admissions and discharges effectively and timely throughout such a large organization (as a hospital) is a challenge.

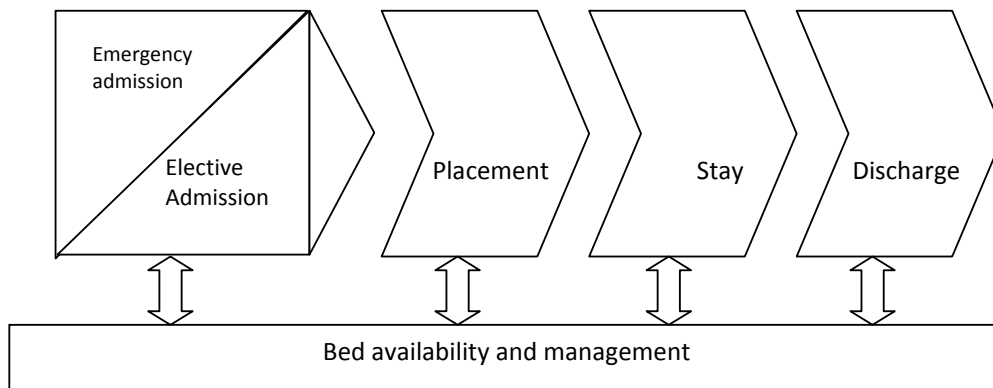


Figure 1: Bed Management Process

Accurate data about who is leaving the hospital on a given day is not always available, so admitting departments continuously struggle with this uncertainty, especially during peak demand. Patients are disappointed to have their scheduled operations delayed or cancelled, “Hospital admissions and discharges are not scheduled like a hotel reservation system” [22]. Lack of bed availability sometimes is worsened and made more persistent by late discharges, the author describes it as being “...much like morning rush hour on highways” [22].

The following needs to be done to make sure that the communication of information is done in a way that would allow bed management to be productive:

- Keeping the lines of communication with the inpatient to make sure that any new or upcoming issues are known and addressed right away.
- The night shift supervisor should have a report ready in the morning for the bed manager, the medical directors, and the unit manager to insure continuity of information and reduce double processing. The bed manager here uses this report to discuss patient throughput issues.

- Discharge data should be collected as well as a scheduled admission list.
- Nurses should meet every morning allowing unit charge nurses to be familiar with the potential discharges from other units
- Based on known discharges, possible discharges and staffing, a plan is set by charge nurses and the bed manager for scheduled admissions with keeping a proper margin for emergency admissions.
- Bed managers should do rounds during the day to check on bed status, and keep associated departments such as Post Anaesthetic Care Unit (PACU) informed of the situation.

In contrary to most literature that describes the bed manager role or the discharge facilitator role as a solution to patient flow problems, one of the studies reported the resistance of nurses when a bed manager position was newly introduced in their hospital for a 6-months trial period [23]. The unit staff felt that discharge should be their responsibility. This trial was based on the notion of making a pull process out of the patient journey. Instead of pushing from front end, it is better to make sure that the end of the process is clear. Another trial that worked for that particular hospital involved reducing bed numbers in a ward, while keeping a staffing level equal to the one that would be present if there were a larger number of beds. This was done with an expectation that in an argument that says that patient/nurse contact time would increase, enhancing patient and staff satisfaction [23]. With the current rise in demand for in-patient hospital care, and the scarcity of resources, this scenario would not be a resolution in most cases.

Another avenue that was taken in tackling patient flow problems concludes that using latest information technology in providing access to real-time information regarding demand for beds and current hospital capacity can be a key solution [24]. Replacing paper-documented information relating to the arrival, transfer and discharge of patients with an electronic data base, can allow instant analysis and timely updates and processing of patient information. The availability of such around-the-hospital accessible data would let bed managers communicate with admission clerks as soon as possible. This allows more control over bed capacities, patient flow and the decision making process to be more effective in accordance to real-time information.

Efforts were not only directed towards defining the responsibilities of resources and engaging the latest technology that could facilitate the patient flow. Getting to understand the processes that dictate this flow is also paramount. The delay tool mentioned above was designed to unravel delays, and for the same objective, modeling techniques were used to identify bottlenecks that are causing those delays [19]. System dynamics modeling is one technique that “combines both qualitative and quantitative aspects and aims to enhance understanding of complex systems, to gain insights into system behaviour.” At a hospital setting, the outcome of these models can be patient pathways, information flow and resource use - wherever dynamic activities are taking place [25].

2.2. Focusing on Discharge through the Healthcare Perspective

Very often when examining efforts to improve patient flow, rather special attention is given to the discharge piece, in some cases, by clearly mentioning it among other issues when discussing bed management, communication of information or even most importantly, delays. This section summarizes the attempts strictly focused on discharge process related issues. By focussing on lengthy patient episodes it was found that “...four types of system obstacles prevented timely discharge; patient care issues, financial and legal issues, administrative issues and deficiencies in coordination between hospital and community personnel. Such nonmedical reasons for delayed discharges suggest that better planning may be beneficial.” [3]

Discharge planning is suffering from a lack of information, poor communication and synchronization between acute and long-term care. Consequently, it results in disrupted flow, blocked beds, frustrated patients and distressed unit staff. Even though the process is never the less always completed, it can be described as “unsuccessful” in some literature. Unsuccessful discharges can either be unplanned readmissions within an unexpected short period of time, or delays in length of stay causing it to be greater than what is set by standards for particular patient groups [2]. Solutions to the persistent problems came generally under [26]:

- Improving liaison
- Planning as far ahead as possible
- Improving communication

- Creating and maintain clear and concise documentation.
- Improving patient assessment.

Research literature is available that expresses and investigates those matters collectively or separately. This section of the chapter will try to cover most of them that fall under efforts conducted by professionals internal to the healthcare discipline.

“Planning cannot begin too early; planning can certainly begin too late. Planning that is not flexible or modifiable as new information comes to light is as bad as no planning at all” [18]. In the general concept of planning, this is very convincing, and for discharge planning in particular this is the recommendation as found in many papers [27][28][29]. Evaluating the risk that the patient might need increased planning efforts for discharge is a key element in preparing for what to do. Doing it early is even better. A study that targeted 36 patients split them into an “early intervention group” and another “control” group. The difference between the groups is that the planning process started at day 3 from admission for the early intervention group and after 9 days for the control group. It concluded that early planning reduced readmissions and facilitated discharge [27].

This risk evaluation can be brought about using tools created by healthcare professionals at the hospital, and a scoring scheme can be identified and used as a base for decision making. Also, it can be done by separately involving all necessary allied healthcare professionals such as social workers, physiotherapists and occupational therapist, but again; the earlier the better. Physicians’ predictions have been found to be valuable enough by themselves. Some of the factors are backed up by rigorous studies and some

are not. The following factors were considered helpful in deciding whether to involve social workers:

- Age and gender.
- Decreased mental function
- Inability to ambulate
- Presence of incontinence.
- Presence of chronic conditions.
- Complexity of social situations.
- Complexity of illness.

By estimating and accounting for the factors above, the need for social work involvement is identified. Getting the requirements fulfilled early enough results in decreased length of stay [29].

Older people come to the hospital with generally more complex health situations that not only require more complex treatment, but certainly bigger discharge planning effort.

Many times they stay for lengthy periods beyond acute medical care [29]. One scoring technique that was created for this matter is the Discharge Planning Questionnaire DPQ [30]. The questions can come under the following: activities of daily living (ADL), instrumental activities of daily living (IADL), and social support and environment issues. Scoring for both categories would come out as: 0 = functional independence, 1 = assistance needed, 1.1 = do not know, 2 = functional dependence. According to the score, the nurse would communicate with social workers and the physician [31].

Interacting with social services is not an easy task by itself; delays and discrepancies might occur. It is important not only to know what the nurses and the physicians need from the social workers, but for them to give the social workers what they need so that both sides have things organized in the best interest of the patient. Through another attempt a computer software was developed to manage discharge - and more importantly to ease the sharing of information [32]. It enabled:

- Capturing data relevant for discharge liaison including referral, assessment and discharge details that are in the hospital patient system.
- Nurses to send electronic referrals direct from the ward or from the discharge liaison office to the social services offices at any time of the day or night.
- The extraction of the most recent status for each patient from the hospital patient system to keep social services up to date. Instant access to information such as patients' next of kin, mobility mental state and any changes in discharge date is possible.
- Social services to maintain their own memo data in relation to a particular case, e.g. social services registration number, or details of which social worker is dealing with the case.

Some of the attempts to address the discharge problem in the United Kingdom were through creating workbooks and setting acts [19]. The Hospital Discharge Planning Workbook [33], published in 1994 was written to highlight the full nature of the process and to ensure that patients are discharged at the right time and with the right arrangements. The National Service Framework (NSF)'s for Older People 2001 [34] and

Discharge from Hospital: Pathway, Process and Practice Workbook 2003 [35] were also prepared for the same reason. The Community Care (Delayed Discharges) Act in 2003 [36] stated the responsibilities for making discharge arrangements so that there would be less disagreement about who is responsible for what. Such workbooks and acts have not been published for the Canadian healthcare system.

A widely problematic aspect of the patient episode at the hospital is the so-called Alternate Level of Care Status (ALC). This status is given to patients that remain in the hospital after their acute care was completed. The reasons are mainly due to unavailability of appropriate long term care facilities and nursing homes. The congestions there create a reverse domino effect influencing surges in inpatient beds and emergency rooms negatively. Hospitals are trying to meet discharge goals and patients and families do feel this pressure creating anxiety in the decision making process of discharge destinations [37].

Recommendations such as increasing hospital and nursing home capacities have been expressed in literature. Other recommendations suggest to “improve the coordination of services to provide a smooth transition across the continuum of care by clearly defining accountabilities for timely and effective client flow”. Projecting demand for alternate level of care facilities is also thought to help plan for how to accommodate for them [37].

The Canadian Institute of Health Information explains that data collection and reporting of ALC is not strictly clear or accurate for some hospitals or some regions around Canada. However they do think that the data is sufficient in beginning to understand the

picture of alternate level of care patients. They also express the large variation in the ALC length of length of stay as depicted in Figure 2. A patient might wait from 1 day to 120 days. CIHI is still working “collaboratively with hospitals and health regions to improve the data. As the data are used and explored, data quality and comparability are likely to improve”. A median of 10 ALC days was reported throughout the years 2006-2008. The long-stay patients did not differ from the shorter-stay patients on demographic variables (gender and age) but were more likely to be in the hospital for reasons related to dementia [38]. However, the overall population of ALC patients might not be representative of the differences between the provinces or cities, and since there is such a wide variation, the results obtained by assessing all patients together might be misleading. Therefore, CIHI poses the question “What are the main sources of provincial and facility variation in ALC? Is it mainly driven by differences in classifying and recording ALC cases or does it reflect key differences in patient care?” [38].

Although some efforts have been put in place to study the reasons for ALC, and the recommendations that suggest improving the situation, deeper investigations need to be made at province, city and individual hospital levels to help understand the variation and contributors to ALC days. Some work in this area has been initiated in the United States [39].

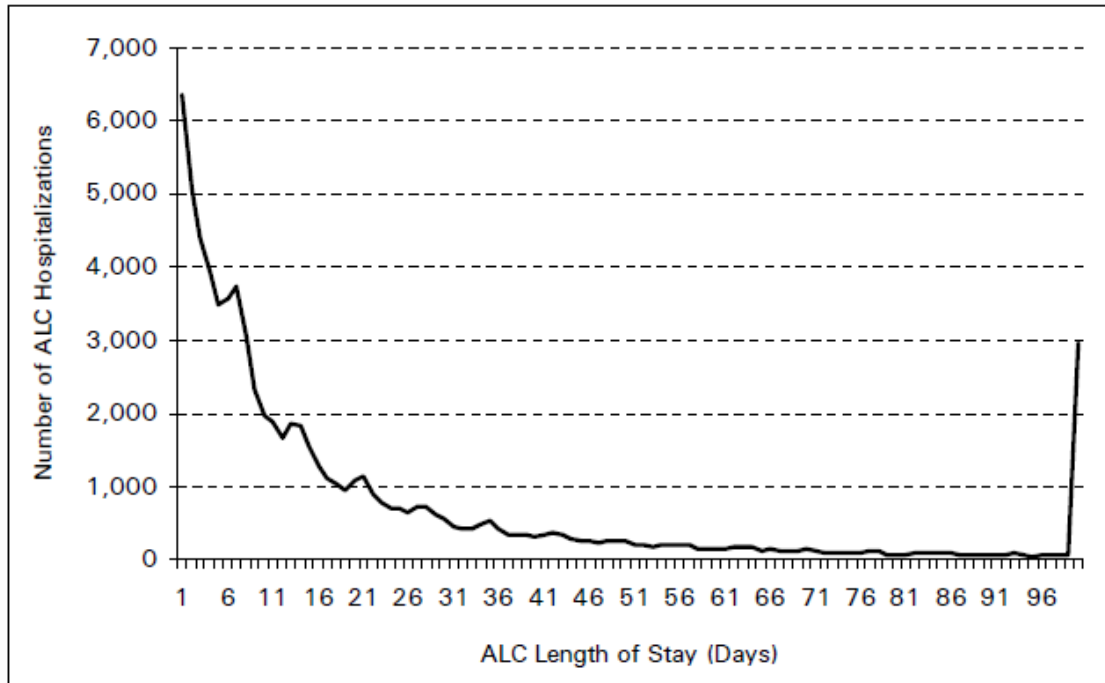


Figure 2: Distribution of ALC Length of Stay in Canada (2008-2008) - (by CIHI 2008)

2.3. Bridging Between Industrial Engineering and Healthcare in Examining Discharge

“Industrial processes provide a benchmark for the healthcare sector in the improvement of production efficiency, assuming it can be achieved without sacrificing clinical quality [40]”. In design and operations management of healthcare systems the patient-oriented approach is widely adopted. This means, that each patient is treated as a project and is managed just like project-oriented companies are managed. Work in Process (WIP) from industry is translated to Patient in Process (PIP) in the healthcare world. The start to finish of a PIP is called a patient episode [40]. When patient episodes vary greatly, effective case management should be combined with process based approaches [41]. Effectiveness was tied to time by the Japanese in the 1980’s. And by doing things with less time a

competitive advantage is achieved. This gave birth to the principle of Time Based Management (TBM). By applying TBM to patient processes, the patient episode can be divided into a series of time categories [40]:

- Diagnostic and care time, including:
 - Diagnostic time of collecting and analysing diagnostic information.
 - Active care time of clinical interventions.
 - Passive care time when resources are not used actively, but the patient is under observation in inpatient units.
 - Superfluous time which is defined as medical diagnostic and care that is not based on official care process recommendation.
- Administrative time that includes all the non-medical tasks related to a patient episode
- Waiting time including:
 - Positive waiting time where the patient's condition is likely to improve spontaneously.
 - Passive waiting time where the patient condition is stable and delay does not influence either the patient's medical condition or the prognosis of the success of medical operation.
 - Negative waiting time that indicates that the patient's condition is likely to deteriorate and they may require more complex procedures. It could also be that the prognosis of patient's (medical) condition after care episode is less favourable.

Another methodology that can be used to deal with the patient processes is called the Soft systems methodology as it is said to be most suited for human activity. Conceptual models are drawn of the current situation and the suggested potentially improved situation. Those models are then compared.

The way this methodology works is by following an approach called Checkland's seven-stage approach whose steps are [17]:

- Steps 1 and 2: involve building the most possible neutral schematic representation of the system and then creating a rich picture of the situation that has all activities connected to each other including all their inputs and outputs.
- Step 3: creating a root definition of the problem using the CATWOE terminology which is broken down to:
 - C - Customer: beneficiary, e.g., patients
 - A - Actor: who performs activities, e.g. healthcare professionals
 - T - Transformation: what input is transformed into what output, e.g. From ineffective to effective continuity of care.
 - W - Weltanschauung: what view of the world makes the system meaningful, e.g. effective continuity of care will deliver high quality individualised care.
 - O - Owner: who can abolish the system, e.g. healthcare professionals.
 - E - Environmental constraints, e.g. socio-cultural.
- Step 4: building a conceptual model, based on the root definition.

- Step 5: comparison of the real world and the systems world in order to propose the agenda for possible change.
- Steps 6 and 7: culturally feasible and systematically desirable changes to structure.

From a study that utilized this methodology, discrepancies in the current discharge planning processes were found to be [17]:

- Patient issues: a tendency for them to change their minds regarding needs for discharge at the last minute, and their being unaware of progress with discharge plans, resulting in their unhappiness with what is being proposed.
- Communication difficulties: including telecommunication problem, delaying referral to occupational therapists or physiotherapists.
- Documentation problem: lack or poor documentation from other healthcare professionals following review of a patient for discharge.
- Time pressures: including nurses being too busy in dealing with patients' physical problems which in turn delays timely progressing of the discharge planning process, over loaded nurses forgetting to communicate with community staff and junior doctors having to wait for their seniors to authorise discharge.
- Policy issues: uncertainly regarding changes in practice resulting from constantly changing government policies and local authority procedures. Also, nurses at the center of the discharge process were not aware of social care policies and criteria that affect their clinical area.
- Others: policy issues, lack of support from the patient's family, patient needs regarding discharge difficult to determine, and equipment needed in the patient

Ideas for improvement included the need for greater cooperation between all that is involved including the patient, and also the adoption of effective communication technologies [17]. The act of communicating with the patient, the family and the long-term care facilities does not seem to be sufficient. The quality in communicating with them determines how successful this act would be. Quality Function Deployment is a way to investigate what the systems' requirements are, and translating them to quality characteristics that should be incorporated in the system with varying importance [42]. In communicating with patients and their families, certain attributes were found to be of significant importance with regards to how the information is passed on, and how thorough, comprehensive and up-to-date is this information, e.g. giving the patients and their families a complete list of long-term care facilities that are available, all the reasons why some are better than others for their particular case and how much they will cost [42].

A model was created by using a so-called "two-part data analysis strategy" with the target of calculating the total number of unproductive days in a patient's episode [43]. This attempt was classified as a "process improvement project" that targeted an inpatient renal unit.

The motive of the study was the fact that there exists a positive correlation between the increased length of stay of older patients with the likelihood of death or nursing home

placement. This correlation is thought to be caused by exposure to complications related to infections, and reduced mobility or cognitive ability with prolonged stays. A less defined concern was said to be that “length of stay is a quality-of-care issue”, especially when related to discharge delays and system inefficiencies.

The paper mentioned the adoption of what was called “The Model for Improvement”, created by the Institute of Health Care Improvement [31]. It requires a response to the questions: What are we trying to accomplish? How will we know that a change is an improvement? And what changes can we make that will result in an improvement? The questions should come in conjunction with the Plan-Do-Study-Act [44]. While proposed in the methodology the use of those techniques and tools was not evident.

The two-part analysis strategy is translated by a flowchart part and a spreadsheet part [43]. The flow chart depicted the stages the patient goes through from admission to discharge, and was prepared through a team brainstorming session confirmed by conceptual framework that was guiding the process. The chart clearly identified a very important milestone in the process which was called “functionally and medically stable for discharge”. Though a very critical point in the patient episode in general and for discharge planning in particular, this point in time was not commonly documented and written in the patient chart at the moment it was identified. In the flow chart an ideal path was set by the team. It was sketched with sub-paths branching out from it illustrating possible delays. The delays were categorized under:

- New or recurrent health issues requiring further assessment or treatment.

- Conflict or resistance to the possibility of discharge from patient or family.
- Late identification of discharge issues.
- Waiting for placement.

The spread sheet came as a quantitative tool complementing what was demonstrated in the flow chart. It was divided into two parts; data entry and meaningful summary. Certain dates were input in the data entry fields that generally resembled starts and finishes to discharge planning related activities. A list of formulae would deduct the total number of delay days for a particular patient.

CHAPTER 3: ANALYSING CURRENT PATIENT DISCHARGE ACTIVITIES

3.1. Introduction

This chapter describes the discharge process from start to end, whether discharge planning was involved or not. Several problems have been discovered while documenting discharge process. In those cases, data has been collected and analysed in order to quantify the problem and identify its nature. The following chapters deal with solving the problems described by this chapter.

3.2. Responsible Resources

It is important to understand who is responsible for what in any work environment to avoid mistakes, double processing, and missing activities. In this case, the job positions that are directly or indirectly connected with the discharge process are: the clinical resource nurse, the nurse practitioner, the registered nurse, the registered practical nurse, the unit clerk, the unit manager, the staff occupational therapist, the staff physiotherapist, the social worker, and finally the physician. The following will be a brief description of what those positions are about and what parts of their responsibilities are related to the discharge process:

- The Clinical Resource Nurse (CRN) is a front line registered nurse who works closely with the unit manager, physicians and other professionals to coordinate care delivery on the unit. He/she fulfills this role by:

- Leading daily multidisciplinary discharge rounds to coordinate delivery of care both internally and externally.
 - Coordinating with appropriate community resources (such as the Community Care Access Center, CCAC) in meeting patient needs.
 - Collaborating with other team members and families/patients to facilitate a smooth transition from the hospital to the discharge destination across the continuum of care.
 - Identifying barriers to discharge and work with appropriate resources to decrease length of stay and readmission.
 - Conducting weekly focused case reviews on the unit.
 - Conducting follow-up calls with patients to assess the effectiveness of discharge instructions and if there were any issues.
 - Communicating with the unit manager, physicians and other professional staff to problem solve and facilitate optimal patient care.
- The Nurse Practitioner (NP) role is to authorize and coordinate admission, discharge, transfers and leaves of absence, and directs referrals to appropriate healthcare professionals or services.
 - The Registered Nurse (RN) is accountable for the provision of care in accordance with the 'standards of practice' as stated by the College of Nurses of Ontario. The RN provides care to meet the holistic needs of these clients in all cases. The Registered Nurse provides consultation and interventions in situations that are beyond the registered practical nurses' scope of practice. The RNs:
 - Assess patients through holistic data collection and ongoing observation.

- Coordinate and participate in the development of the interdisciplinary plan of care in collaboration with the client.
- Identify opportunities for quality improvement as well as initiate, participate and evaluate quality improvement initiatives.
- Actively participate and contribute to change of shift report, team meetings, and discharge planning.
- Take responsibility and accountability for documentation of all care delivered.
- Actively contribute to the collaborative effort to improve quality of patient care, decrease patient length of stay and increase appropriate bed utilization.
- The Registered Practical Nurse (RPN) is similar in responsibilities to the RN by providing care to meet the holistic needs, but mainly for individuals experiencing less complex care situations with predictable outcomes. When the RPNs provide aspects of care in situations beyond this, they will do so in collaboration with the RN and other care providers.
- The Unit Clerk position is a self-directed member of the care team and is responsible to facilitate and ensure the effective coordination of all clerical communications for the unit. The unit clerk:
 - Maintains an accurate and complete patient record while on the unit.
 - Ensures patient appointments and arranges transportation.
 - Notifies the Admitting Department of admissions, discharges, and transfers

- Prepares memos, letters, statistics, and reports for unit specific information as required.
- The Unit Manager role is in ensuring that quality is not compromised and that day-to-day operations are efficient. The role promotes an optimal patient experience through timely recruitment and ongoing development of the professional and non-professional staff that support the efficient functioning of the patient care unit. The unit manager is also a role model for change and ensures that staff is well prepared and supported in the implementation of change. The unit manager:
 - Interacts with Patient Care Resource Leader to ensure that discharge planning actively begins at time of admission.
 - Ensure that optimal resource management is achieved by the unit. This includes effective discharge planning and development of quality assurance programs.
- The Staff Occupational Therapist (OT) provides patient care services including assessment, treatment and education in order to meet the needs and expectations of the patient on receipt of an authorized referral. The OT is able to integrate patient information to develop and progress an effective, efficient, goal-oriented treatment plan.
- The Staff Physiotherapist (PT) provides patient care services including assessment, treatment and education in order to meet the needs and expectations of the patient in terms of their physiological well being. This aspect of the patient condition is vitally related to their dependence/independence after discharge.

- The Social Worker (SW) manages a caseload of those patients requiring discharge planning services. He/she applies appropriate clinical intervention methods to meet both the client's and the organization's interests. The social worker:
 - Works in collaboration with interdisciplinary team members to identify patients who will require assistance with inpatient, outpatient and/or post-hospital care needs
 - Assesses the patient's functional, mental capacity and limitations/strengths in activities of daily living
 - Assists in the formulation of a plan of care that compliments the goals of the patient and family and the healthcare team
 - Provides counselling to the patient and/or their family as may be required in the adjustment of the individual's physical, social, emotional, financial and vocational needs, also in making decisions about their plan of care
 - Makes arrangements for out of town referrals by coordinating with community resources
 - Initiates and organizes meetings with families, community resources and interdisciplinary team members as necessary
 - Reassesses the plan of care on an ongoing basis
 - Provides education and information to interdisciplinary team members about social systems and community resources and their impact on discharge planning.
 - Interact with community agencies and services to provide ongoing care for patients when needed beyond hospitalization.

- The physician is the medical doctor that is responsible for accurately diagnosing the patient and deciding on the course of treatments and interventions that are to be implemented. Alongside following up with the patient's medical condition the physician should be able to predict the length of stay. He/she should also issue referrals to other healthcare professionals when necessary, who will also help form the picture of the patient's needs after acute care. The physician is responsible for determining the point where the patient is done receiving acute care and is medically fit for being discharged. Providing prescriptions for after hospital medications and necessary instructions before discharge are also his/her responsibility. Finally the physician should dictate a discharge summary that will summarize the complete patient episode. That is to be added to the patient's chart after discharge in case it was needed for later reference.

3.3. The Discharge Process

3.3.1. Activity Characteristics as Recognized by the Hospital

Currently, the discharge process at the hospital does not seem to have an identified process structure. It is mainly witnessed as the point where the patient is ready to leave in a day or two, and what needs to be done right before that. However - as it has been explained in previous sections - there is a list of activities that happen well before that point in time. They directly influence how the patients proceed through their stay. Each patient is unique based on the type and severity of illness, age, gender, social standing and multiple other factors. This variety can be misleading, and results in the perception that a

generally common process cannot be defined precisely for inpatients. What lacks is an understanding of what most patients go through under the sequence of involvement of those responsible resources.

3.3.2. Identifying the Discharge Process Sequence and Structure

A series of interviews were conducted with hospital staff. The collected information was used to form a picture of the sequence of the discharge process elements. Figure 3 shows a flow chart of the process when the patient undergoes a relatively simple discharge procedure. It includes certain activities common to all patients. Right after a patient is admitted, an admission record sheet asking for certain information is filled out for the patient that starts. One of the fields is the diagnosis, which should give an indication of the expected length of stay (ELOS) parameter. If the patient diagnosis falls under one of the clinical pathways that are defined by the hospital, then the patient's treatment is set off according to that pathway that has day-by-day instructions.

After a few days from admission, a Multidisciplinary History and Physical Assessment are done mainly by a nurse and the physician. It is a 4 page document that has a thorough general patient health analysis. The fields present in this document related to discharge are:

- Location the patient was admitted: home, rest/retirement home, long term care, complex continuing care, and others...
- Information of contact persons: the decision maker, family spokesperson, care partner.

- Living arrangement: who lives with the patient, the type of residence, the mobility status.
- If Community Care Access Center was previously caring for the patient or not.
- Planned discharge destination.
- Expected date of discharge.

At the end of this document there is a section referred to as ‘functional assessment’ that is done for the purpose of determining if social workers should be involved with this particular case. A list of fields are present that can be answered as either independent, needs assistance of one person, needs assistance of two people, dependent, or needs equipment. Examples of such criteria are: ability to turn and reposition in bed, ambulation, bathing, grooming, grocery shopping...and many others. If the patient was listed as not independent in 5 or more of these, then they should be referred to discharge planning.

Provided that the patient had less than 5 dependencies and he/she (or their family) did not specifically request the social work services, this patient is not recognized as considered one that has discharge planning involved with their hospital stay. When the patient has almost completed treatment and recovery, the nurses notify the patient that they will leave soon, and notify the family that they should pick up the patient on the day of discharge at 11:00am or earlier. It is believed that discharging patients in the morning time is better for them since that is when they usually feel their best.

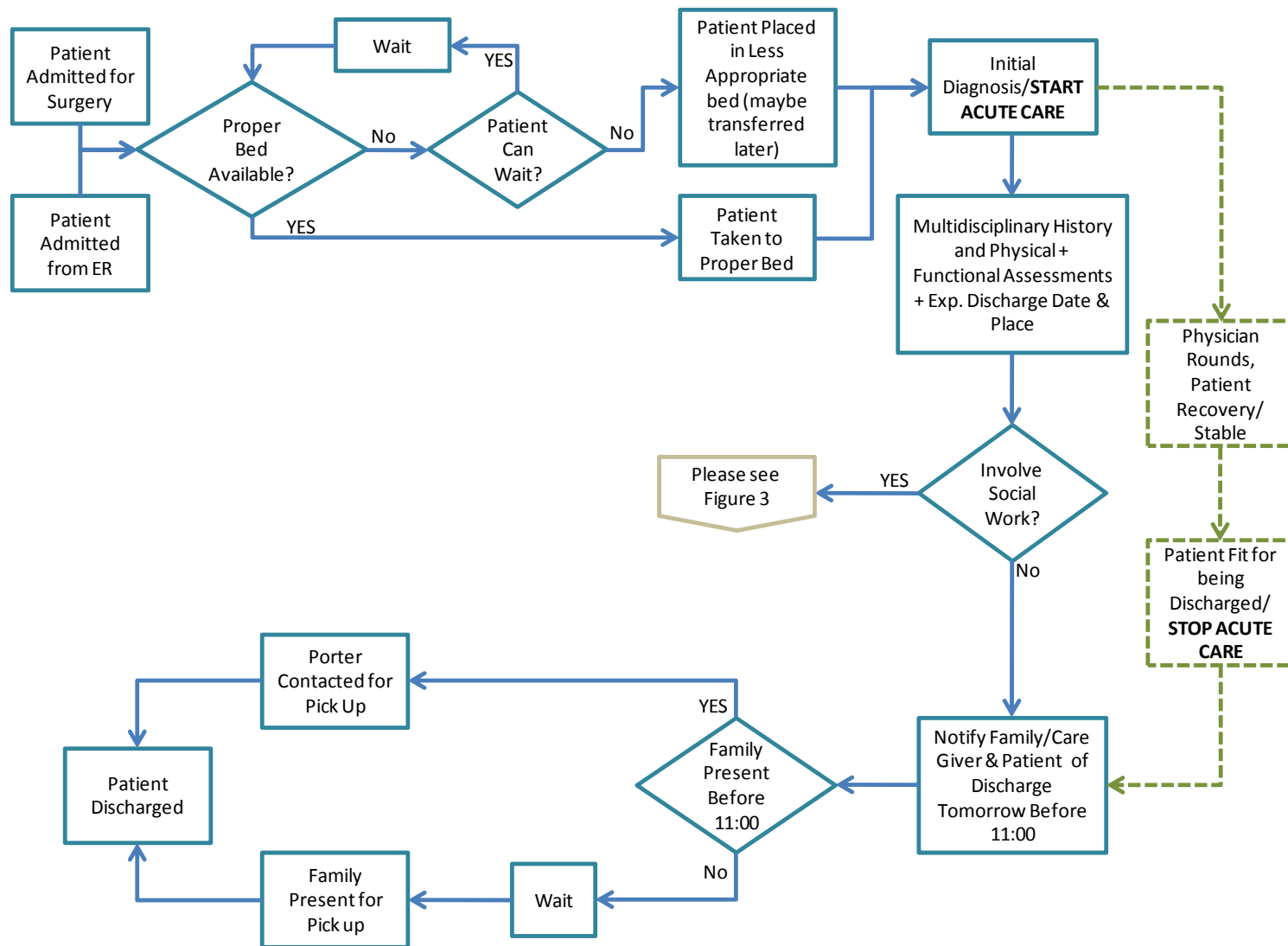


Figure 3: Patient Flow Chart with Emphasis on the Discharge Process

Early discharge allows new patients to be also admitted early enough for tests to be ordered and results received the same day. This ensures that the proper diagnosis and treatment may start as soon as possible. However, very often this goal of discharge before 11:00 am is not met.

Before the patient leaves the hospital he/she should take a copy of another document; the Discharge Information sheet. This sheet has all the information that the patient might need to know upon leaving the hospital, from the procedures that have been performed, prescribed medications and specific physician's instruction. He/she usually needs to present this document at their next follow up visit to the hospital or family doctor. It is worth noting here, that while most of the above is being done, the patient would be undergoing acute care in parallel (this is represented by the path in dashed lines in Figure 3).

3.4. The Discharge Planning Process

3.4.1. Activity Characteristics as Recognized by the Hospital

When the patient's functional assessment yields a result requiring interaction with the social work department, the flow chart in Figure 3 seems to lack a very important path, the discharge planning path. As was the case for the general discharge process, a proper sequence and structure of this path was not identified. However, there were some influential efforts in place that separately defined and facilitated some of the discharge

planning activities, in particular the ones related to the decision making process of the most appropriate discharge destination.

Discharge Planning is a list of activities that try to ensure the best transition possible for patients that will still require some type of care after they are done receiving acute care at a hospital. It is within the responsibilities of discharge planning to “recognize the danger of shifting patients from one healthcare agency to another” [45]. Discharge planning and continuity of care are not exactly the same, discharge planning is more of:

- Assessing and identifying current and anticipated psychosocial and physiological needs.
- Planning appropriate continuity of care to meet those needs when a change or termination of services by the current health care provider occurs
- Preparing and referring the patient for admission to another organized healthcare service.
- Preparing the patient for self care.

Continuity of care is more of a series of events that occur continuously according to patient needs while they may vary [45]. The activities are mostly ones that do not fall under the acute care category and can be taken care of outside the acute care hospital. The follow up however is accompanied by accurate communication of information about the patient between both healthcare service providers.

At the hospital, discharge planners are social workers. The hospital has a social work department of 5 workers under supervision of a single manager. Each two units at the

hospital share one worker on a given day. A discharge planner that was given a case remains responsible for that case until it is closed. They make daily rounds to check patients' health status to discuss and communicate about any changes in their needs. They meet with involved family members every time a decision has to be made, and they fill out applications for patients that will either require placement or continuing care at home.

A more detailed overview of the possible discharge destinations is present in a flow chart that the hospital prepared, and is shown in Figure 4. The figure illustrates the categories of destinations that should be chosen according to previously made decisions regarding the patient health status and care needs. In conjunction with this flow chart, a care delivery criteria matrix was also designed to show the appropriateness of each category of discharge destinations according to listed criteria that should be almost comprehensive of all patients' needs. This matrix (Table 2) provides the choice of which avenue to take.

In one of the units at the hospital, two big sheets that are enlarged versions of both Figure 4 and Table 2 are hung on the wall to help communicate this information to patients and care givers, in hopes of reaching to an agreement faster and easier.

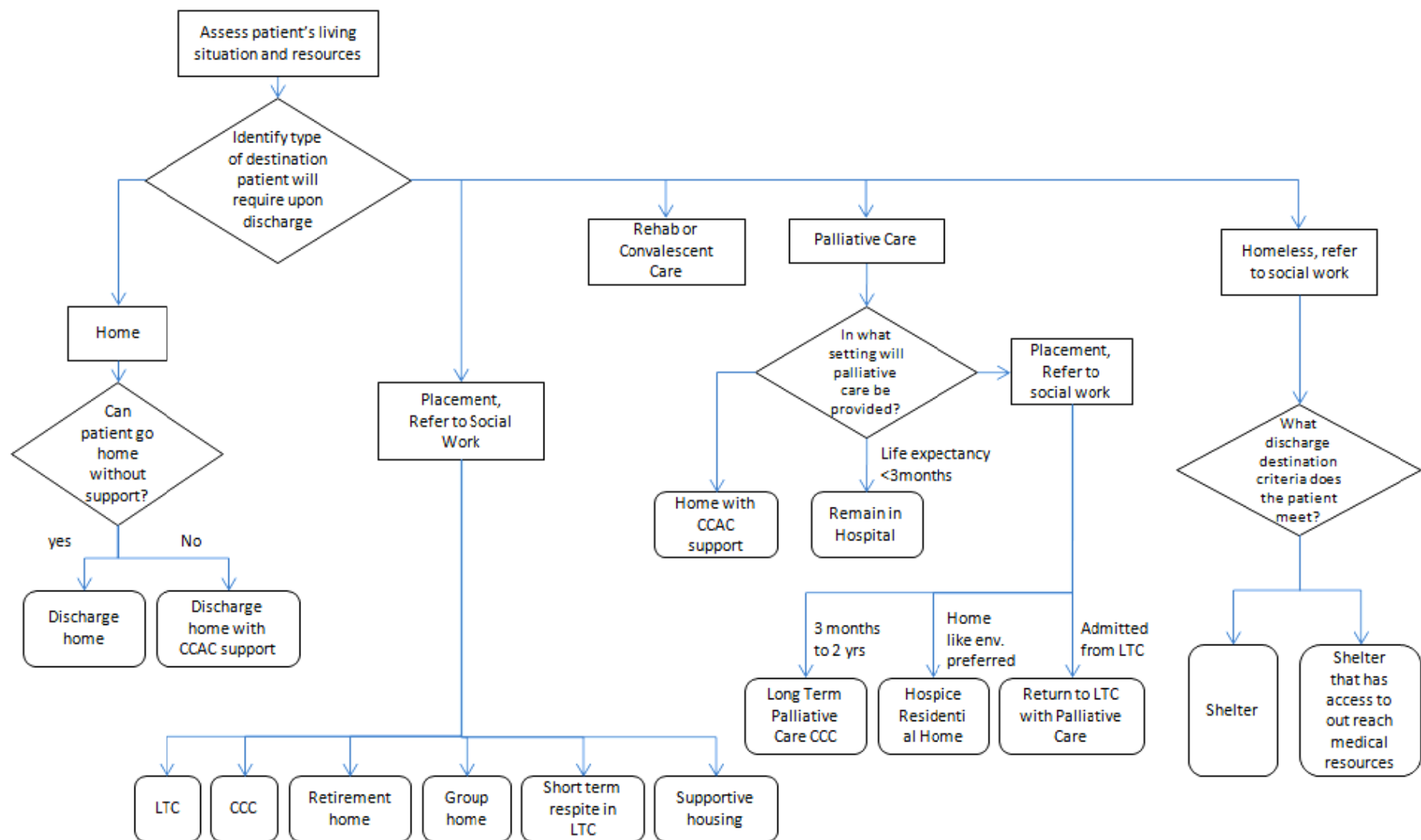


Figure 4: Flow Chart of After Discharge Destinations (by HDGH)

Table 2: Criteria for Discharge Destinations (by HDGH)

	Hospital acute care	Home			Rehab.				Placement					Hospital PC				
		Home	home with CCAC support	Home with Private and Comm. Supports	Rehab. In-house	Rehab. Short Term External (WRH)	Rehab Long Term External	Convalescent Care (NCCP)	Short Stay Respite	Long Term Care LTC	Complex Continuing Care (CCC)	Retirement Home	Group Home	Supportive Housing	Palliative Care Short Term	Palliative Care Long Term (CCC)	Hospice Residential Home	Shelters (homeless)
GENERAL																		
Patient/Family consent to plan	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Age 18 +								x	x	x	x			x		x		
Able to direct care		x		x	x								x	x				x
LOS expected to be 90 days or less							x	x	x						x	x	x	
Will benefit from rehab./realistic rehab goals			x		x	x	x	x				x	x	x				
Tolerates minimum 3 hours in wheelchair					x	x	x	x		x								
Exercise tolerance level adequate					x	x	x	x		x								
Refugee status	x		x		x	x	x								x			
MEDICAL CARE																		
Medically stable		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Specialized needs can be met - often with CCAC support (i.e. O2, other...)	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
All pertinent medical test results reviewed		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hospital D/C goal has been established		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	
Potential to return to previous level of functioning or increase current level		x			x	x	x	x										
Needs greater than 3 hours professional care (i.e. complex would care)				x							x				x	x	x	
PALLIATIVE (o: Palliative patients can go home with plan developed with CCAC Manager)																		
End stage disease	x	o	o	o						x	x	x	x	x	x	x	x	
Acute palliative care symptoms	x	o	o	o											x			
Consent to Do-Not Resuscitate (DNR)	x	o	o	o						x					x	x	x	
Less than three month life expectancy	x	o	o	o							x				x	x	x	
BEHAVIOR																		
Manageable behaviour		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cognition- able to learn and follow instructions					x	x	x	x				x		x				x
Willing and motivated to participate					x	x	x	x				x		x				
Understand consequences and decisions														x			x	x
Aggressive uncontrolled behaviours	x																	
FINANCE																		
Valid OHIP			x			x	x	x	x	x	x		x	x	x	x	x	
Income based (financial resources are adequate)				x					x	x	x	x		x				
Income based (financial resources are not adequate)					x	x	x			x	x		x	x	x	x	x	x

Once the decision has been made regarding the type of continuity of care that is agreed upon by the patient and family, an application is sent to that facility/organization. For facilities that have waiting lists, the patient will only be placed on that list once his/her application is complete and sent.

3.4.2. Identifying the Discharge Process Sequence and Structure

The previous section mentioned the tools used to facilitate destination decision making. This is only one step of the process of discharge planning. The steps that come before and after that are discussed in this section to draw another flow chart with the inclusion of the discharge planning path (Figure 5).

When a social worker receives a referral request from the nurse in charge, they show up to meet with the patient and their family, and they take action according to the situation. Every time they meet with the patient or carry out any of their duties they write a note of what has been done on a note pad called ‘progress notes’, so that when any other healthcare professional arrives to check on the patient, they would be able to know where the patient is at this moment in terms of their discharge planning.

Another assessment activity that is done to determine what action to take in terms of discharge planning is what is called the Blaylock Discharge Planning List. This sheet contains more comprehensive criteria that enable more accurate decision making as to what resources will be needed after the patient is done with his/her acute care. From this assessment, a score of 10 indicates that the patient is at risk of requiring home care

resources. A score from 11-19 indicates a risk for extended discharge planning. A score of 20 or higher indicates that the patient is at risk of requiring placement.

If the patient does require placement or continuing care at home, social work sends a request to the Windsor and Essex Community Care Access Center (CCAC) which is connected to all those organizations and facilities that will provide continuing care services throughout the region.

CCAC sends a case manager to assess the patient that was identified by the discharge planner/social worker as one that requires placement or other services. The case manager studies the eligibility of the patient for placement and starts processing the application. The patient is asked to provide three preferences among the list of all the nursing, palliative and retirement homes. They are placed on the waiting list in those three locations until a spot becomes available in any one of them. The hospital has a policy that says that if the patient refuses to choose three preferable locations, or refuses to go to the first available bed because it was the least preferred one, or for some other reason, then he/she must pay \$600 per night.

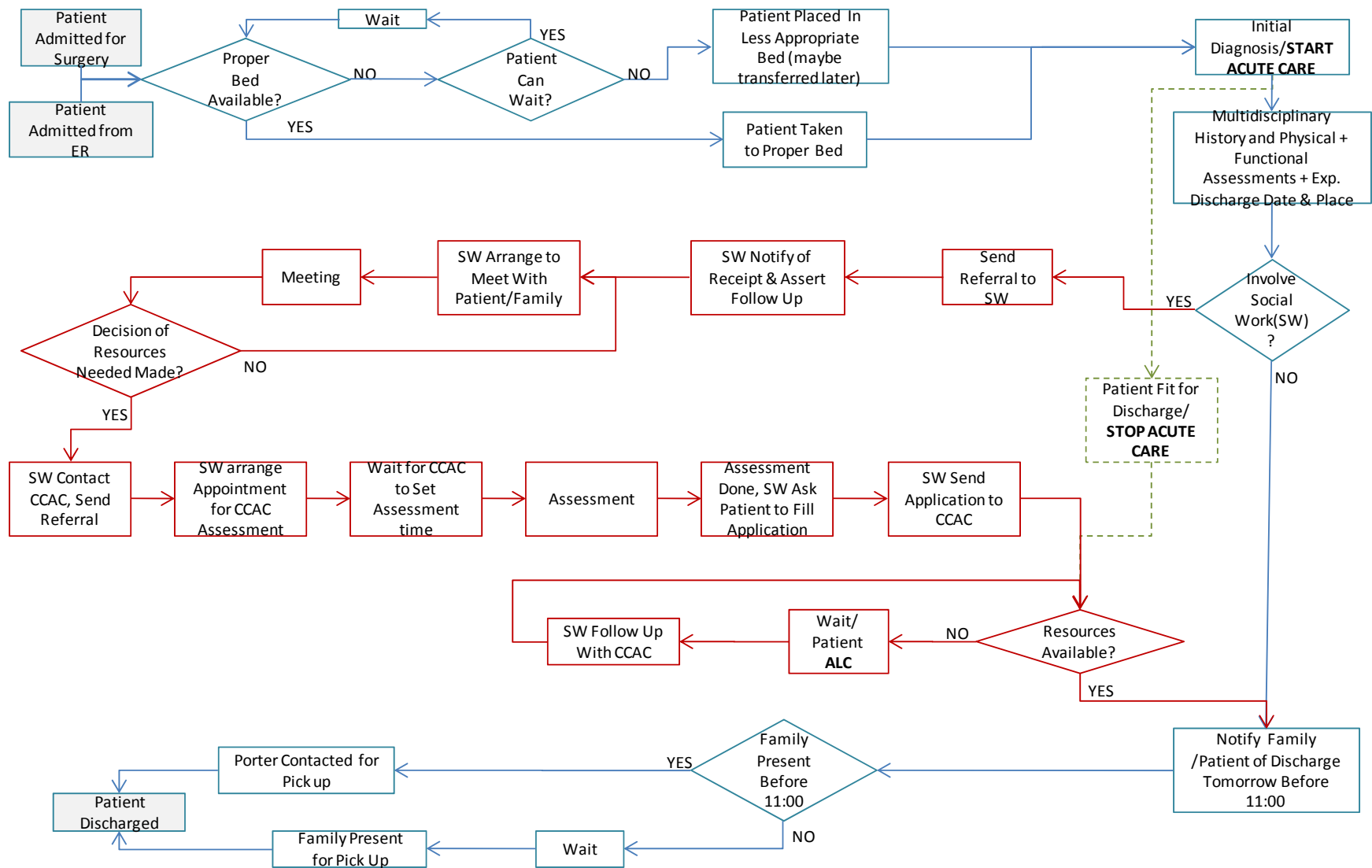


Figure 5: Patient Flow Chart with Emphasis on Discharge Planning

3.5. Bed Meetings and Planning for Patient Flow

3.5.1. Activity Characteristics as Recognized by the Hospital

Bed meetings are daily gatherings of representative nurses from all around the hospital and are conducted to share information regarding the status of their units. There, the Coordinator of Patient Flow meets with those charge nurses and announces:

- Bed occupancy percentage on that day.
- Openings for transfer of patients from the hospital to another acute care hospital in the region.
- Number of patients in the hospital awaiting transfer that are put on the waiting list of other hospitals in the region.

The information that is given to the manager by the nurses includes the following:

- Patients that are surely leaving that day at their unit.
- Patients that are possibly leaving that day at their unit.
- Patient transfers that are to be made that day from unit to unit.
- Patients that now require isolation due to infections they have caught (e.g. Vancomycin-Resistant Enterococcus (VRE), Methicillin-resistant Staphylococcus Aureus (MRSA), Clostridium Difficile (C-Diff)).
- Patient gender in all the points above.

Inpatient units at the hospital consist of 5 medical and 3 surgical units. Surgical patients are sent either to 6- East, 6- West - which specialize in orthopaedics and general surgery respectively - or to the Neurosurgical Unit. The medical units and their specialties are:

- 2 – North : general medicine
- Telemetry (TEL) : biotelemetry (i.e., people with the risk of abnormal heart activity)
- 7 – East: renal
- 7 – West: general medicine
- Neurology (NEU)

The numbers of predicted discharges that are brought to this meeting are translated into the number of admissions that can happen that day. Decisions are made to appropriately admit patients relative to certain criteria as being for a medical or surgical patient, a female or male, a patient that requires isolation or not, a patient that prefers a ward bed, a semi-private bed or a private bed.

Since the hospital is operating at or above 95% capacity most of the time, the predictability of what is going to happen is essential. To add to the criticality of the situation, it is known that the demand for beds is large and rising, and those are the reasons that describe the importance of the status of every bed in the hospital. The Patient Flow Coordinator stated that the information in the bed meeting is used as a base for decisions to allow the operating rooms (OR) to go forward that day or refrain from conducting certain surgeries. If there is a large mismatch in predicted discharges then OR

patients would have to stay in the post anaesthetic care unit (PACU) all night; which is not ideal for the patient's health.

For medical units, 99% of their admissions come from the emergency department (ED). As it is well known, ED patients in Canada are experiencing largely elevated wait times; which is a topic that appears in many research efforts. The case at this hospital is not different. Therefore, the predictability of discharges and improvements in the discharge process tends to affect inpatient units, and the ED as well; a department which is already struggling.

Another metric that can be used by the hospital in order to predict discharges and plan for admissions is called the Expected Length of Stay (ELOS). This metric corresponds to the number of days the patient is expected to stay at the hospital. The number is generated by comparing patient characteristics with a database prepared by the Canadian Institute of Health Information (CIHI). All hospitals in Canada (except ones in Quebec) send data to CIHI who later classify patients based on diagnosis, co-morbid conditions, interventions and age groups. According to this information CIHI provides hospitals with Case Mix Groups (CMGs) and expected lengths of stay. Based on a coding process of patient characteristics and their corresponding CMG, the ELOS is derived. If the hospital has determined ELOS for each patient, they would be able to predict when this patient is supposed to leave; hence, when another patient can be admitted in their place.

3.5.2.Data Collection and Problem Identification

In order to examine and unravel the details behind the performance of both the predictions brought to the bed meetings, and the accuracy of the expected length of stay, data has been collected and analyzed.

3.5.2.1. Accuracy of Discharge Information at the bed meetings

The data collected from the bed meetings included the expected daily discharges over a two-and-a half month period. Missing days were the holidays, weekends, and the days the Patient Flow Coordinator was not present and the meetings were not conducted. The parameter of interest was the accuracy of predictions of discharges that were brought to the meeting. The accuracy was calculated by comparing the ‘for sure’ predicted discharges and the ‘possible’ predicted discharges with the ‘actual’ discharges that happened that day. Since the information is bed specific, the comparison was made bed-to-bed for all the inpatient units. In other words, if for example, as patient in bed number 260A was predicted to leave, and this patient actually was discharged from bed 260A that day, then this prediction would be counted as a correct prediction. “Sure” predictions and “Possible” predictions were treated the same for simplicity. The daily accuracy was calculated as follows:

$$\text{Accuracy \%} = ((\text{Total correct possible predictions} + \text{Total correct sure predictions}) / (\text{Total discharges})) * 100\% \quad \dots (\text{eq.1})$$

Based on the above, the accuracy was calculated for 47 days and the results were analyzed and tested for normality using SPSS (Ver16). The test for normality will be explained in this section and any further normality tests in the remainder of this paper will be interpreted the same way. The results are summarized in Table 3. Figure 6 shows a histogram plot for the data, a Q-Q plot that shows linearity and a box plot that shows no outliers. The analysis shows that the data generated a P-value of 0.200 for the Kolmogorov-Smirnov statistic of 0.086. The P-value being larger than the commonly set base of comparison of 0.05 shows that the data fits the normal distribution well. Kurtosis and Skewness are measures of deviation from normality (SPSS). Kurtosis measures how high or low is the peak of the distribution. Skewness measures how symmetrical or asymmetrical is the distribution. If both values were between $\pm (2 \times \text{their standard error})$ then this indicated an acceptable deviation for normality.

Table 3: Descriptive and Normality Test Results for Daily Accuracy of Predicting Discharge

Variable	Mean	Std. Dev	95% CI		Kurtosis	St. Err	Skewness	St. Err	Kolmogorov-Smirnov	
			LB	UB					Statistic	P-Value
Daily Accuracy	.507	.113	.474	.54	-.879	.62	.034	.35	.086	>.200*

* Using a two-tailed $\alpha = 0.05$

A value close to zero for both indicates that the data is close to normal and that the distribution is symmetrical depending on the application. Values between ± 1 are considered sound, sometimes values between ± 2 are considered acceptable. With a Kurtosis of -0.879, Skewness of 0.0344 and a P-value of 0.002 the data meets the

conditions for assuming normality; hence the data can be described as normal, with its mean and standard deviation.

A mean of 0.507 and a standard deviation of ± 0.1125 were indicated, along with a 95% confidence level (CI) that the accuracy of predictions is between 47.41% and 54.02%.

This means that about 49% of the information taken to the admissions department is erroneous. Consequently, that describes the research's first discovered problem.

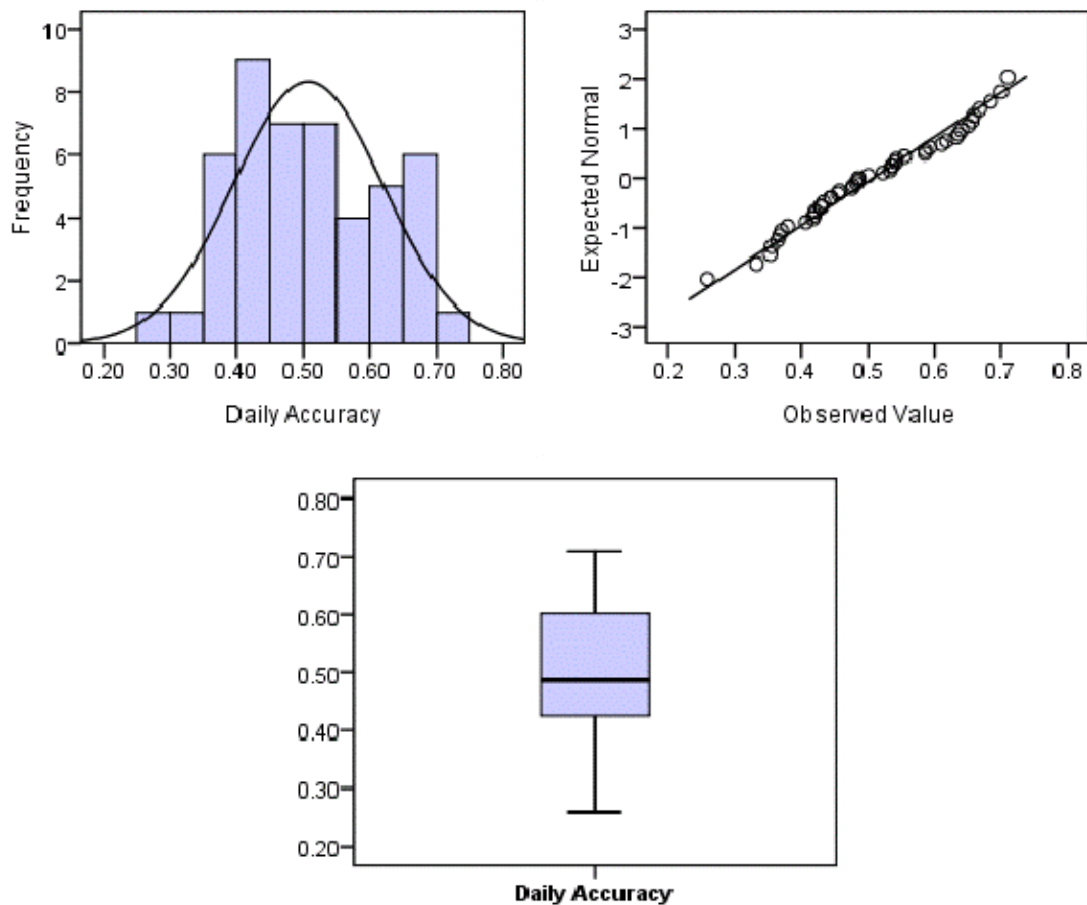


Figure 6: Histogram and Test of Normality Plots for Daily Accuracy

After this problem has been identified, deeper analysis was conducted to see whether there was a difference in the level of accuracy of information coming from medical units in comparison to surgical units. It was found that the data for both followed a normal distribution and the analysis is summarized in Table 4.

Table 4: Descriptive and Normality Test Results for Medical and Surgical Units

Variable: Daily Accuracy	Mean	Std. Dev	Kurtosis	St. Err	Skewness	St. Err	Kolmogorov-Smirnov	
							Statistic	P-Value
Medical	.478	.134	.211	.68	.419	.35	.077	>.200*
Surgical	.587	.201	-.156	.69	.269	.35	.092	>.200*

* Using a two-tailed $\alpha = 0.05$

Since the normality assumption holds, the difference between the samples can be tested using independent sample t-test (Table 5).

Table 5: Results of T-Test for Difference of Accuracy between Medical and Surgical Units

Medical/Surgical	Levene's Test for Equality of Variance		t- test for Equality of Means		
	F	P-Value	t	df	P-Value
Equal variances assumed	4.958	0.028*	-3.085	91	0.003*
Equal variances not assumed			-3.072	78.234	0.003*

* Using a two-tailed $\alpha = 0.05$

In this case equal variances should not be assumed and that the p-value of 0.003 for the t-test indicated that the means of the two groups are different. Since equal variances can be assumed from the test, and the mean accuracy of predictions for surgical units is larger

than that of the medical units (0.587 and 0.478 respectively), it seems that surgical units are doing a better job in predicting discharges.

3.5.2.2. Deviation Between Actual LOS and Expected LOS

Data was obtained from the hospital covering 1744 patients. 4 cases were filtered out since they were patients with zero acute days spent at the hospital, meaning they were not inpatients. This data was used to see how close are the expectations to the actual amount of days a given patient stays at the hospital. The LOS and ELOS for each patient were obtained and the descriptive information for both data sets does not meet the assumptions for normality (see Table 6, and Figures 7 and 8), hence they will be treated as nonparametric samples. Since ELOS and LOS are related to the same patient, the test that will be used is for two related samples; the Wilcoxon test. It tests whether the two related samples have the same median.

Table 6: Descriptive and Normality Tests for LOS and ELOS

Variable	Mean	Std. Dev.	Kurtosis	Skewness	Kolmogorov-Smirnov	
					Statistic	P-Value
LOS	22.66	21.7	9.5	2.45	.166	<.001*
ELOS	14.186	15.59	12.28	3.21	0.224	<.001*

* Using a two-tailed $\alpha = 0.05$

The results for the Wilcoxon ranks test for LOS – ELOS are summarized in Table 7.

Since the test is significant with a p-value < 0.001, it is concluded that there is a mismatch

between the actual LOS and the expected LOS. The medians indicate that patients tend to wait a longer than expected.

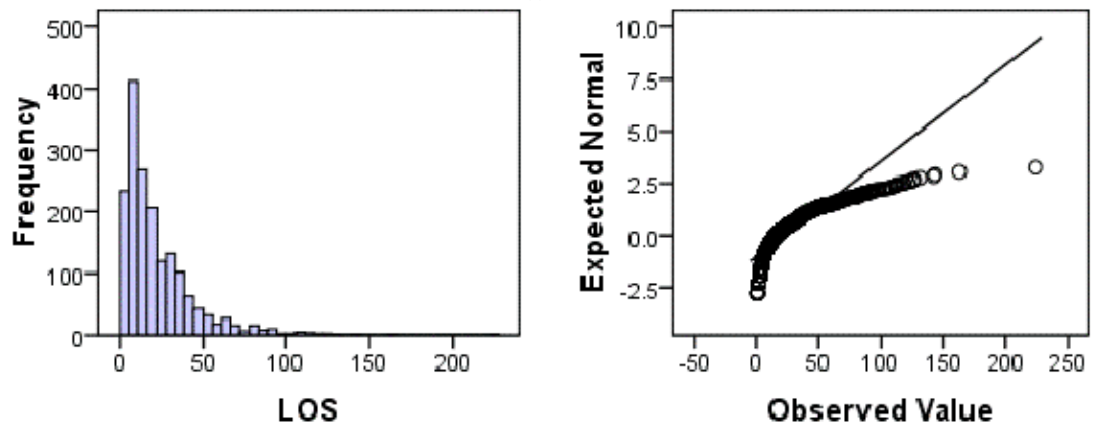


Figure 7: Deviation from Normality for LOS

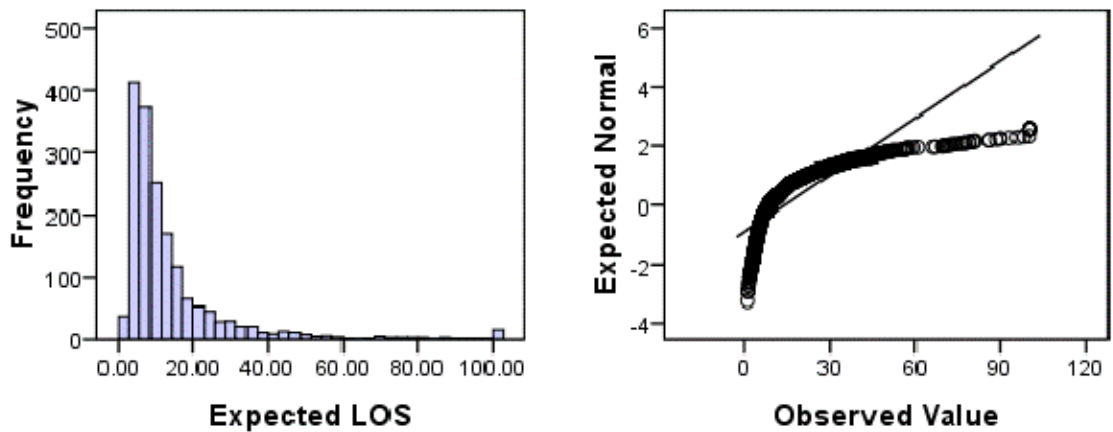


Figure 8: Deviation from Normality for ELOS

Table 7: Results of Wilcoxon Ranks Test for Difference between LOS and ELOS

Variable	N	Mean	Std. Dev.	95% CI		Median	Wilcoxon Ranks Test	
				LB	UB		Z	P-Value
LOS	1740	22.66	21.7	21.64	23.68	16	-20.85	>.001*
ELOS	1740	14.186	15.59	13.45	14.92	9		

* Using a two-tailed $\alpha = 0.05$

Hospitals target to run at about 90% of the capacity, however the median of LOS is 16 and that of ELOS is 9, therefore patients seem to be staying longer than expected. This may explain the fact that the hospital is frequently running at above 95% of its capacity. The mismatch also indicates that expectations are not met. This section describes the discovery of yet another problem along-side the lack of accuracy of predicting discharges. Both create discrepancies and reduction in smooth patient flow, distancing the hospital from meeting their larger goal.

3.6. Alternate Level of Care

3.6.1. Activity Characteristics as Recognized by the Hospital

Once a patient is declared medically fit for being discharged, he/she will no longer be receiving ‘acute care’. If for any reason, the patient does not leave the hospital after that, they will be given the status ‘Alternative Level of Care (ALC)’. The number of days a patient stays in the hospital while he/she is not receiving acute care are also named ALC days. If patient was initially reported as ALC, but left the same day, the patient will not be

considered ALC. The length of stay for ALC cases cannot be captured unless it is equal to or greater than 1 day. The reason a patient might be holding the ALC status can be:

- Requiring other physical therapy.
- Requiring palliative care: meaning convalescence following; surgery, radiotherapy, chemotherapy, psychotherapy, treatment of fracture, combined treatment, other treatment, or unspecified treatment.
- Homelessness.
- Inadequate housing.
- Problems related to living in residential institution.
- Other problems related to housing and economic circumstances.
- Person living alone.
- Need for assistance at home and no other household member able to render care.
- Medical services not available in the home.
- Person awaiting admission to adequate facility elsewhere.
- Other waiting period for investigation and treatment.
- Unavailability and inaccessibility of health-care facilities.
- Unavailability and inaccessibility of other helping agencies.
- Holiday relief care.
- Other problems related to medical facilities and other healthcare.
- Health supervision and care of other healthy infant and child.
- Healthy person accompanying sick person.
- Other boarder in health-care facility.

Examples of such reasons can be:

- No ambulance available to transport the patient back home, patient waits additional days.
- Patient waiting for availability in a long-term-care or a rehabilitation facility.
- Married couple admitted, one is finished with acute-care, but cannot go back home alone, waits ALC days till partner is also ready to be discharged.

3.6.2. Historical Data and Problem Identification

The existence of ALC days is in itself a problem. Theoretically they are unnecessary days of bed occupancy that should be used by people requiring acute care; the type of care that cannot be provided to a patient anywhere besides the hospital. In the discharge process they are without a doubt the largest bottleneck. ALC days are even often referred to as bed blocking days. This section will show certain statistics regarding ALC days, and the problems they cause.

3.6.2.1. Understanding the Size of ALC Days

Data was collected from the hospital for the same sample of patients used in the LOS versus ELOS comparison in Section (3.5.2.2.). As can be seen in Figure 9 the sample of 1740 patients had:

- 62% (1079 patients) waiting zero ALC days; meaning they finished their acute care and left right away. They were never given the ALC status.

- 38% (661 patients) waiting ALC>0 days; meaning they were given the ALC status.

Although a higher percentage of patients do not wait ALC days, the 38% waiting patients contributed to substantial total of 11,462 days. Those days were summed up from the period between April 2007 and February 2009; these days could have been spent providing acute care to other patients. From this large sample of patients a median of 12 days was obtained for the number of acute care days spent at the hospital. Considering this median value and the number of ALC days spent, it can be said that during those ALC days, the hospital could have cared for an additional 955 patients in the 23 month period. The cost associated with those days is momentous, accounting to \$7,168,200 between April 2007 and Feb 2009, giving an average cost of \$3,739,930 per year (\$311,660 per month). The hospital has 212 inpatient beds, and if it is running at close to full capacity (say 97%) most of the time then there would be about 75060 bed days/year. Since there are about 6000 ALC days/year, ALC beds account for 8% of the capacity.

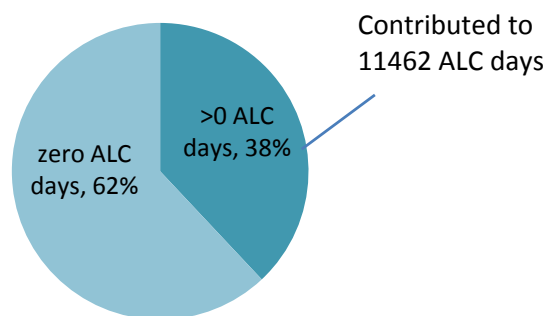


Figure 9: Pie Chart of Percentage of ALC Patients

According to the historical data, ALC days for a patient can range from 1 to about 120 days indicating a confusing large variation. The reason for waiting ALC days was provided for each patient. Ninety nine percent of ALC cases were due to “awaiting admission or resource availability in receiving facility”. It means that there is limited availability in long term care facilities, rehabilitation centers and nursing homes, and limited availability of resources that provide continuing care at the patient’s home. Even if the reason for ALC mostly lies outside the hospital, it is important to understand the factors contributing to ALC days, only then planned efforts of tackling this problem can be properly directed. This is the main task that this project intended to achieve.

3.6.2.2. ALC Days and Accuracy of Predicting Discharges at Bed Meeting

Recall from section (3.5.2.1) that there was a significant difference by the t-test between the daily accuracy provided by the predictions from medical units and surgical units from. And if the difference in ALC days between medical and surgical units was explored, the results will show that in general medical patients can be given the ALC status sufficiently more often than surgical patients. The pie charts in Figure 10 illustrate this result.

Due to lack of data linking them both together (ALC days and daily discharge predictions), this project cannot prove that ALC is the contributor of lack of accuracy, however due to the significant difference in the amount of ALC patients in medical units, this research suggests that there might be a link between the poorer accuracy of medical units and the significant large amount of ALC patients they hold when compared to surgical units.

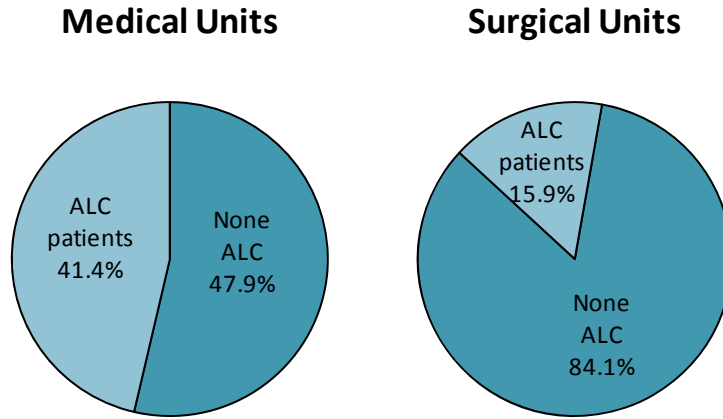


Figure 10: Pie Charts of percentage of ALC Patients among Medical and Surgical Units

3.6.2.3. ALC Days and Deviation From Expected LOS

This section explored whether ALC days have an effect on the deviation from expected length of stay. This variable was calculated as the absolute value of the difference between LOS and ELOS as follows:

$$\text{ABSDevLOS} = |\text{LOS} - \text{ELOS}| \quad \dots (\text{eq. 2})$$

The test for normality for this variable showed many outliers and the measures of deviation (kurtosis = 10.812, Skewness = 2.833) when compared to their standard error suggest that the data under the variable do not meet the assumptions for normality (see Table 8. A \log_{10} transformation was not considered here for the concern of data with zero ALC days, hence the sample size remained as N= 1740. In order to see whether there is a correlation between ABSDevLOS and ALC days, they were assigned as dependent

variable and independent variable respectively in a Spearman's rho correlation test (that does not require the assumption of normality).

Table 8: Descriptive and Normality Test Results for ALC days and ABSDevLOS

Variable	Mean	Std. Dev.	Kurtosis	St. Er	Skewness	St. Er	Correlation Spearman's rho	
							Coeff	P-Value
ALC days	6.59	13.82	19.32	.12	3.75	.06	.55	.000*
ABSDevLOS	12.47	16.26	10.81	.12	2.83	.06		

* Using a two-tailed $\alpha = 0.05$

The results indicated that the test is significant; and that there is a correlation between the two variables. The coefficient 0.55 implies a strong positive correlation. Consequently, it can be said that an increase in ALC days results in a poorer expectation of length of stay. Therefore, not only do ALC days pose a delay problem, but it also contributed to the previous problem mentioned in section (3.5.2.2). This effect is illustrated in Figure (11).

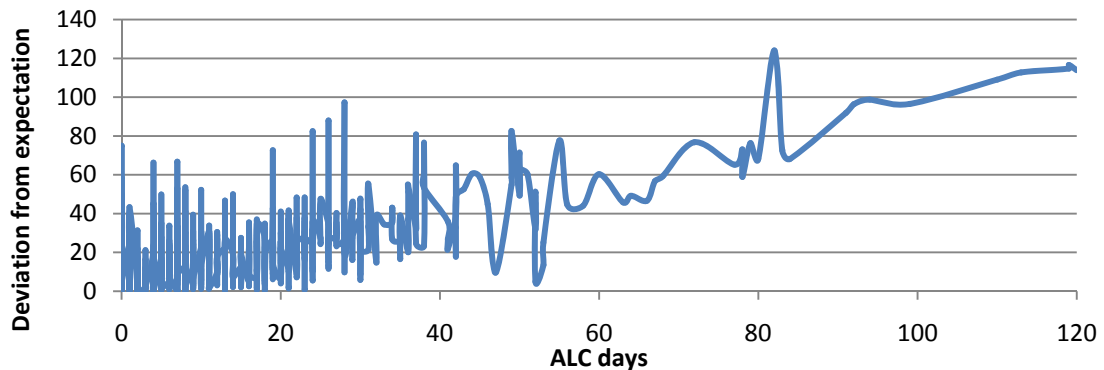


Figure 11: Relationship of Deviation between LOS and ELOS with ALC days

3.7. Red – Yellow – Green Light Initiative

3.7.1. Activity Characteristics as Recognized by the Hospital

The concept of the color codes red, yellow and green is recognized worldwide. The difference of interpreting them depends on the subject that they are being applied to, certainly indicating a negative stance by red and a positive one by green. One example of its previous use in healthcare is when it was linked to bed status at a hospital. There, the bed status was given out every four hours on information boards present at different locations where department managers and physicians are most likely to visualize it. For them, the red status meant that patients are being held in the emergency department or the post anaesthesia care unit (PACU). Yellow, meant that there is reduced bed availability and green meant that the hospital is performing well with its patient flow [46].

HDGH hospital is aware of the necessity to synchronize the discharge processes and to provide adequate discharge planning. One of the unit managers was involved in a so-called Flo Collaborative pilot project that was done in the region. It is aimed at reducing the length of stay of elderly patients that are awaiting availability in other care facilities (ALC days). One of the main initiatives that were brought to the hospital as a result, is the Red-Yellow-Green Light strategy. When asking any unit manager or nurse that is involved with patient care about discharge planning, before they start talking about the hospital's discharge planners or any other aspect of the discharge process, they speak of the RYG - light initiative. They do believe that this activity is most worthy of mentioning in describing what the hospital does in terms of facilitating discharge.

The color code is given as a bed status according to the condition of the patient occupying it. If the patient is not likely to leave anytime soon, the status would be red, and is indicated by a red pentagon shape hung on a white board by each bed. If the patient is likely to leave within the next two to three days, a yellow sign is placed, while a green one is put if the patient should leave within the next 24 hours. In the case the patient is done receiving acute care and for any reason cannot leave the bed, then a blue shape is put instead, and this status is named ALC.

One medical unit states that since the start of this initiative, a significant decrease in LOS has been reported and the visual signs make the situation clear for everybody involved. Both nurses and physicians have been asked to provide their opinion about the predictions of status. In that unit, all nurses and most physicians tend to comply with this initiative and provide their prediction of status. However, in other units, the nurses are mainly the ones that are defining the status, while the physicians are still not providing much support to that activity. The hospital believes that it would be helpful if the physicians do provide their input since they might be able to better judge the consequences of the patient's conditions, and in the end, they are the ones that trigger the discharge process by declaring the patient as 'fit to be discharged'. The idea behind anticipating the yellow and green statuses is to encourage all healthcare providers to complete necessary complementary work before the discharge day and to allow the family/care givers to be prepared.

The goals of this initiative include getting to a point where the hospital is discharging 75% of ready patients before 11:00 am. As far as the strategic goals of the hospital, this initiative aligns with the Smooth Flow and Affordability strategic goals.

3.7.2. Historical Data and Problem Identification

Although the initiative characteristics and goals sound promising, the data used in the analyses of the previous section points out that even after the employment in the initiative there are still many patients awaiting ALC days. Since the ALC problem might not be mainly caused by the hospital, this incident is not surprising. However, due to criticality of the hospital patient flow situation, any slight improvement is worth the while.

The point in time at which this initiative started on the different units was identified. Since there is difference in the sample size under each unit (in terms of ALC days), it was thought best to select medical units for this particular study as they contributed to most of the ALC days. The top three ALC contributing units were 2N, 7E and 7W and hence were chosen for a ‘before and after’ comparison.

CHAPTER 4: ANALYSIS OF ALTERNATE LEVEL OF CARE

4.1. Introduction

Due to the problems mentioned in Chapter 3, and the incomprehensible variation in ALC days across the country, thorough analyses were necessary. This chapter contains the analysis of ALC days and all other available patient characteristics. A linear regression analysis was conducted in an effort to uncover the factors contributing to ALC days. Then a logistic regression analysis followed to measure the likelihood of awaiting ALCs days.

4.2. Preparing ALC Data (The Dependent Variable)

In order to analyse ALC days, the first step was to filter out ALC days= 0. An important assumption in linear regression is that the dependent continuous variable meets the assumptions of normality. After eliminating patients that did not wait any ALC days the considered sample size consisted of 661 patients. Looking at the ALC day's histogram in Figure 12, it is very clear that the shape does not indicate normality. To achieve better regression analysis quality, it is thought better to use normally distributed data. Therefore, the data was transformed to their Log10 value, and the test for normality showed a significant improvement in the distribution. A summary of the descriptive of ALC and \log_{10} (ALC) is listed in Table 9. Visual improvements due to the transformation are depicted in Figures 13-14. The \log_{10} value of ALC was used in the univariate and linear regression analyses that follow.

Table 9: Descriptive Results for ALC and \log_{10} (ALC)

Variable	Mean	Std. Dev.	Kurtosis	St. Er	Skewness	St. Er
ALC	17.34	17.78	9.63	.19	2.690	.1
Log10(ALC)	1.044	.44	-.01	.19	-0.44	.1

* Using a two-tailed $\alpha = 0.05$

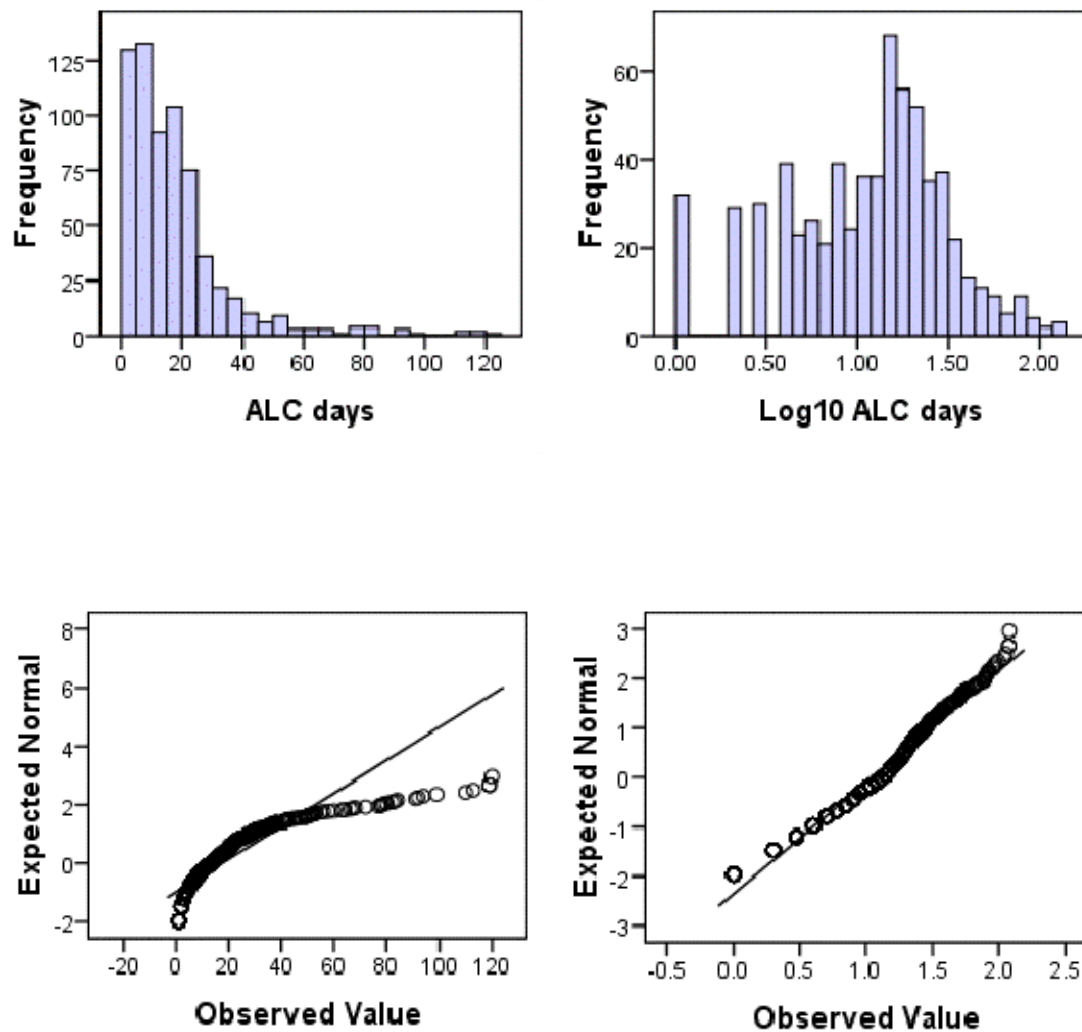


Figure 12: Improvement of Normality by Transforming ALC days to \log_{10} (ALC days)

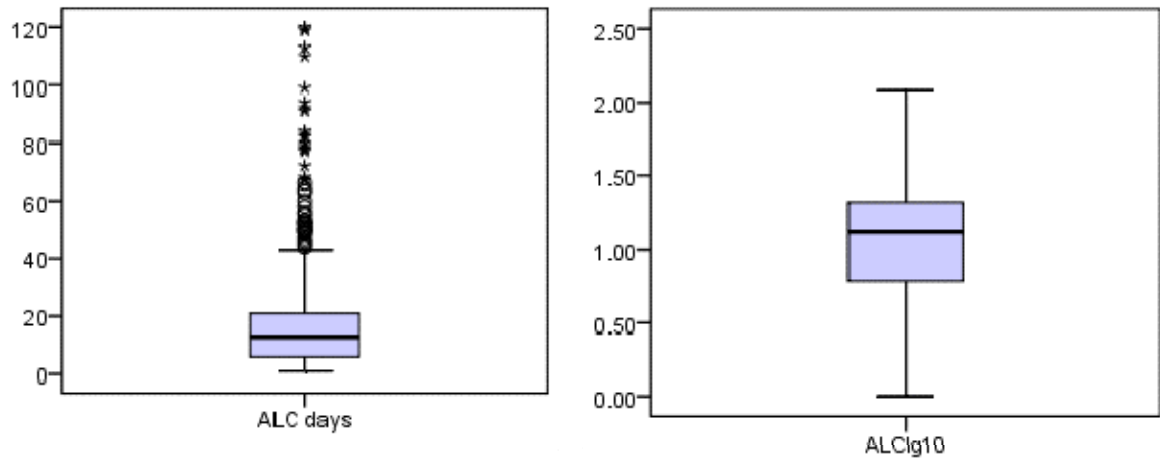


Figure 13: Box Plots of Showing No Outliers after Transformation

4.3. Preparing Other Data (Independent Variables)

The independent variables under investigation were gender, age, acute care days, unit type, and type of receiving institution. The severity of illness score (Acute Physiology and Chronic Health Evaluation (APACHE) [47]) of each patient would have been an important consideration, unfortunately this score is not calculated or recorded for inpatients and was not part of the data provided. The variables were tested for normality and prepared for an unadjusted univariate analysis.

4.3.1. Gender and Age

Gender is nominal variable with two categories, male and female. T-test can be used to see if there is a difference between the two groups in terms of \log_{10} (ALC). Age is a continuous variable. The descriptive summary is listed for the age variable in Table 10. The distribution deviates from normality by its kurtosis and skewness and outliers as seen

in Figures 14 and 15. Consequently it was transformed into a categorical variable of two groups:

- Non seniors (patients below the age of 65)
- Seniors (patients 65 year of age and above)

The reason for this particular categorization was due to the general observation that the need for discharge planning and the number of ALC patients are both much more abundant between the ages 65 and above; a phenomenon frequently mentioned in previous literature. Since now in a categorical form, age no more needs to meet the normality assumption and can be tested against $\log_{10}(\text{ALC})$ using the t-test.

Table 10: Descriptive Results for Age

Variable:	N	Mean	Std. Dev.	Kurtosis	St. Er	Skewness	St. Er
Age	661	79.2	10.7	.70	.19	-.886	.095

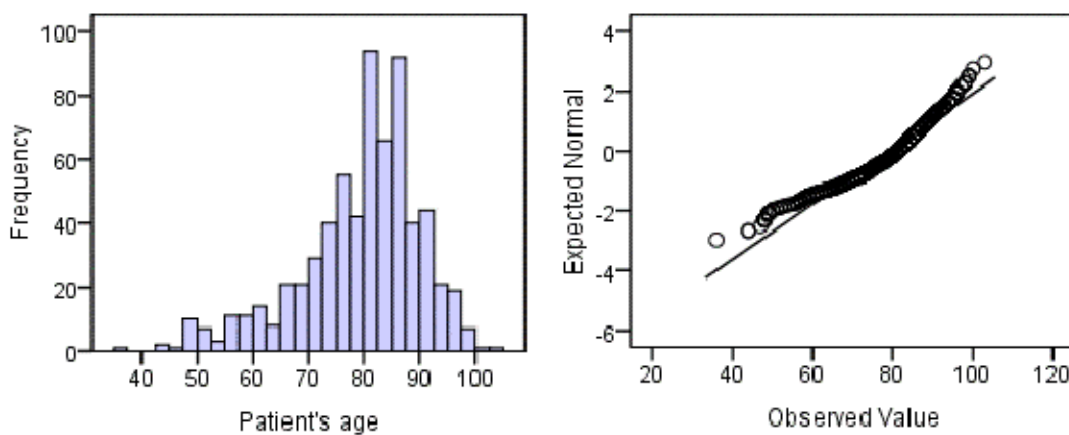


Figure 14: Deviation from Normality of Age

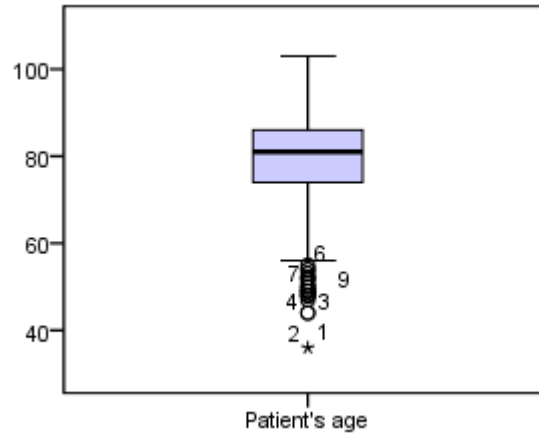


Figure 15: Outliers in Box-Plot of Age

4.3.2. Acute Care Days

Acute Care Days is a continuous variable. The way it is, deviation from normality is evident; however a \log_{10} transformation was beneficial. The results of before and after the transformation are described in Table 11 and Figure 16. The box plot after transformation shows a few outliers. Outliers can be dealt with in one of three ways; being deleted, given the value of the mean or given the nearest appropriate value (last value within the $Z = \pm 3.29$ range). Here, four of them were replaced by the nearest acceptable value; over all the Z values are now all well between ± 3.29 . Such a continuous variable can be tested for correlation to \log_{10} (ALC) using Pearson correlation.

Table 11: Descriptive Results for Acute Days and \log_{10} (Acute days)

Variable	N	Mean	Std. Dev.	Kurtosis	St. Er	Skewness	St. Er
Acute Days	661	17.85	16.51	12.379	.19	2.77	.01
Log10(Acute days)	661	1.1	.37	-.082	.19	-.19	.01

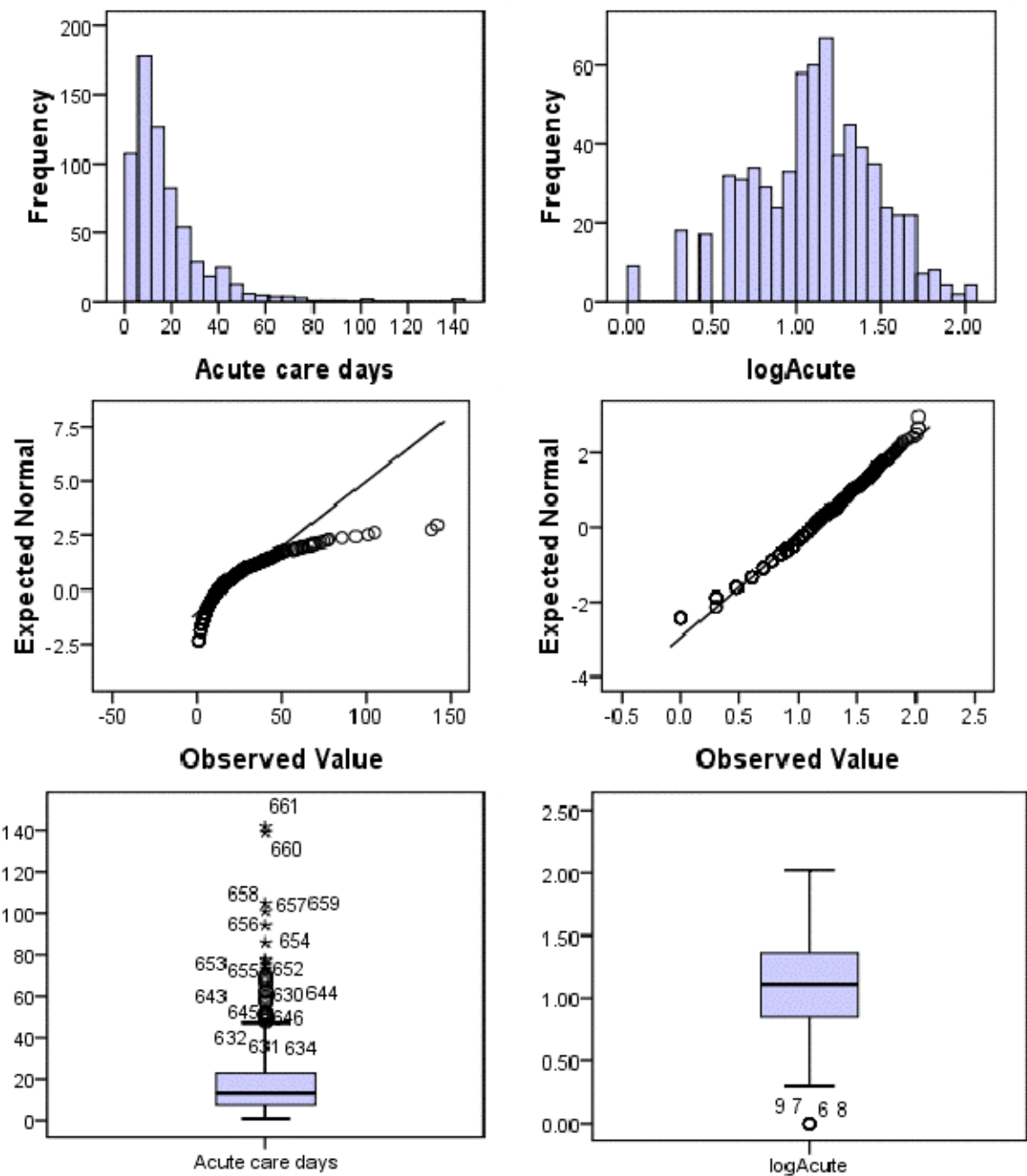


Figure 16: Improvement of Normality of Acute Days after Log_{10} Transformation

4.3.3. Unit Type and Institution Type

Unit type is a nominal variable; it represents the 8 different unit types at the hospital.

Different units are specialised in certain ailments or procedures. As such, a categorical variable can be tested for a difference in ALC days by using Log10 (ALC) and conducting a One-way ANOVA test. Institution Type is a nominal variable as well; it represents the 7 different institutions that provide continuing care to patients after discharge. It is also to be tested using ANOVA. The following is an explanation of the different categories:

- Acute Institution: Another hospital that provides acute care that this hospital HDGH does not provide.
- Support Care and CCAC: Is usually the short of Community Care Access Center. This center links patients with all continuity of care resources, however in this analysis it is only considered as the intuition that provides either provides care of the patient at home, or home like environment (e.g. rest of retirement home). The rest of the facilities are labelled as separate categories. It was not clear why they were given in separate categories, but they were kept as such so see whether similar results are obtained for them at the end.
- CCC: is the abbreviation of Complex Continuing Care. It is a type of long term care where specific services are provided to complex health situations.
- LTC: a long term care facility (excluding complex care)
- Mental Health: is self explanatory
- Rehab: a rehabilitation center (whether for physical or addiction related problems)

4.4. Unadjusted Univariate Analyses

In order to study the factors affecting or contributing to ALC days (or similarly to the log10 of ALC days) a linear regression analysis was selected. However, the approach that was taken to select those variables was through univariate analyses that test the effect of each variable on ALC days separately. This is a preliminary step that guides the way to ruling out factors that might not be significant in the regression.

Although all tests are commonly significant at a p-value of less than 0.05, this significance might change when combined with the effect of other variables and vice versa. A p-value of 0.25 was the base for ruling the variables in or out; a value of less than 0.25 might turn out to be significant in the regression model, while a value larger than 0.25 is very unlikely to change. Different tests were conducted for different variables according to variable type. The test selected for each variable is described in Table 12 along with the test results.

As can be seen from Table 12 all the variables are to be included in the linear regression analysis. In order to account for the different categories, dummy variables were created for the Unit Type and Institution Type. The reference from unit type was taken to be Neurosurgery and Mental Health from Institution Type; the rest were dummy coded.

Table 12 Tests Selected for Univariate Analysis and Test Results

Variable	Type	Categories	Mean (log10ALC)	Test	Statistic	P-Value*	Result*
Age	Nominal	None Seniors Seniors	1.150 1.031	Independent Sample t-Test	t = 2.171	0.030	Significant Include
Log10(Acute Care Days)	Continuous	-	1.104	Pearson Correlation	Coeff . = 0.076	0.052	Not significant Include
Gender	Nominal	Females Males	1.007 1.103	Independent Sample t-Test	t = -3.234	0.001	Significant Include
Unit Type	Nominal	2 North 6 East 6 West 7 East 7 West NEU NSX TEL	1.167 0.817 0.480 1.094 1.006 1.201 0.918 0.752	Test for Homogeneity of Variances	Levene Statistic= 2.028 p-value = 0.05	0.000	Significant Include
				ANOVA	Welch = 13.29		
Institution Type	Nominal	LTC CCC Mental Heath Acute Inst. CCAC Rehab Support Care	1.229 1.150 0.900 0.975 0.749 1.095 0.884	Test for Homogeneity of Variances	Levene Statistic= 2.771 p-value = 0.008	0.000	Significant Include
				ANOVA			

* Using a two-tailed $\alpha = 0.05$, included if $p \leq 0.25$

4.5. Linear Regression Analysis (Factors Contributing to ALC)

This section explains the factors contributing to ALC days to and what extent they explain its large variability. The Linear Regression model was set up as follows:

- Dependent Variable : Log10(ALC), continuous and meets the assumptions of normality
- Independent Variables: Gender, Log10(Acute days), None Seniors, Seniors, Unit 2N, Unit 6E, Unit 6W, Unit 7E, Unit 7W, Unit NEU, Unit TEL. (Unit NSX was the reference), Inst Acute, Inst CCAC, Inst CCC, Inst LTC, Inst Rehab, Inst. Support Care (Inst MH was the reference).
- A Forward Stepwise approach; the stepwise selection of significant variables that contribute most to the variation in ALC days.

4.5.1. Linear Regression Results

The model was significant with an R^2 of 0.23 as shown in Table 13. The list of included variables was; Inst LTC, Inst CCC, Unit TEL, Inst Rehab, Unit 6W, Inst CCAC, Unit 6E, Unit 2N, None Senior, Senior. The remainder of the variables were not significant to the forward stepwise linear regression model. The correlations between \log_{10} (ALC) and the variables are listed in Tables14 and 15. Resulting residuals are plotted in Figures 17-19.

Table 13: R^2 and ANOVA Test for Linear Regression Model

R	R^2	St. Err	ANOVA (Model/Residuals)	P -Value
0.477	0.228	0.389	F = 20.75	<0.001*

* Using a two-tailed $\alpha = 0.05$

Table 14: Linear Regression Coefficients of Model Variables

Coefficients	B	Std. Err	Beta	t	P-value *	Tolerance
Constant	1.013	0.056		18.027	<0.001	
Inst LTC	.313	0.04	0.338	7.827	<0.001	0.653
Inst CCC	.231	0.048	0.196	4.775	<0.001	0.721
Unit TEL	-0.327	0.072	-0.161	-4.455	<0.001	0.965
Inst Rehab	0.158	0.061	0.101	2.59	0.010	0.796
Unit 6W	-.632	0.176	-0.126	-3.585	0.000	0.983
Inst CCAC	-.153	0.052	-0.115	-2.915	0.004	0.786
Unit 6E	-0.129	0.053	-0.089	-2.428	0.015	0.901
Unit 2N	0.086	0.037	0.084	2.136	0.021	0.929
None Senior / Senior	-0.102	0.050	-0.072	-2.031	0.043	0.959

* Using a two-tailed $\alpha = 0.05$

Table 15: Correlations of all Variables in Linear Regression Analysis

Variable : log₁₀ (ALC)	Correlation	P - value*
Patient's Gender	0.099	0.006
Log₁₀(Acute)	0.069	0.039
Age(None Senior/ Senior)	-0.085	0.015
Unit 2N	0.166	<0.001
Unit 6E	-0.179	<0.001
Unit 6W	-0.115	0.002
Unit 7E	0.084	0.017
Unit 7W	-0.46	0.122
Unit NEU	0.081	0.020
Unit TEL	-0.154	<0.001
Inst Acute	-0.021	0.293
Inst CCAC	-0.258	<0.001
Inst CCC	0.102	0.005
Inst LTC	0.294	<0.001
Inst Rehab	0.032	0.212
Inst Support Care	-0.219	<0.001

* Using a two-tailed $\alpha = 0.05$

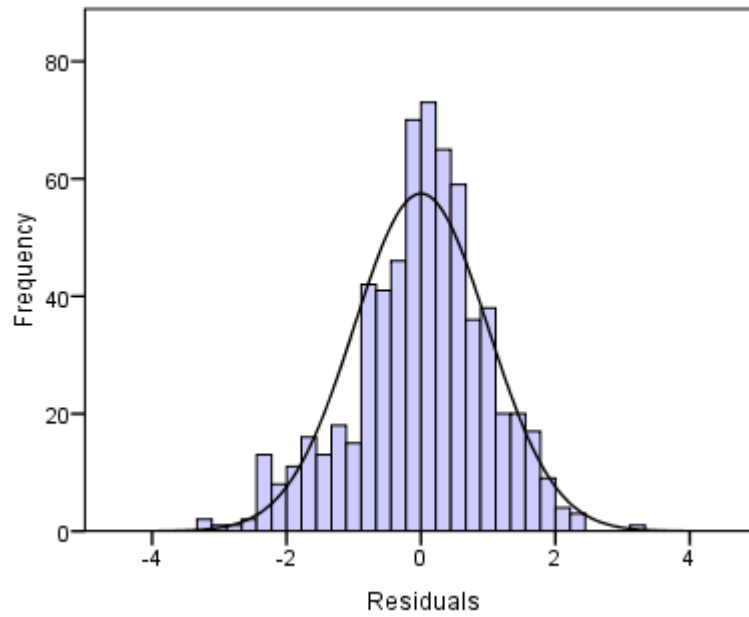


Figure 17: Histogram of Residuals

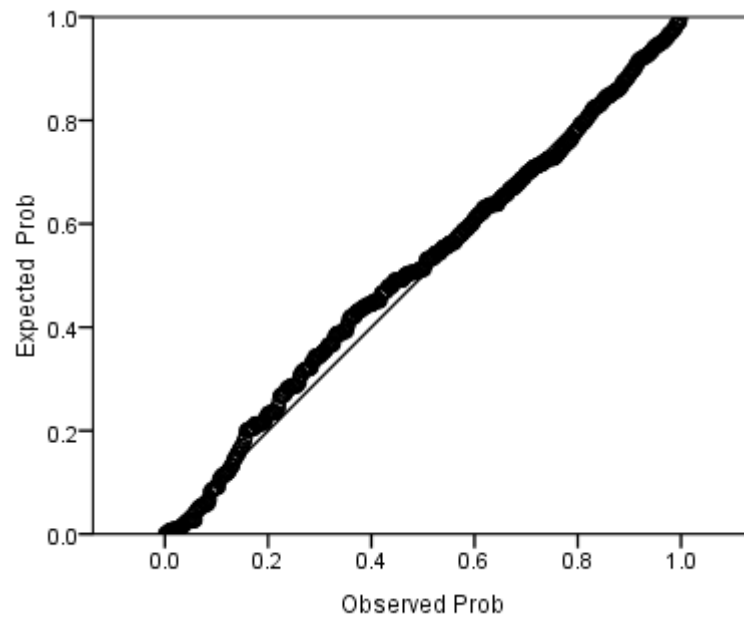


Figure 18: Linear Probability Plot of Residuals

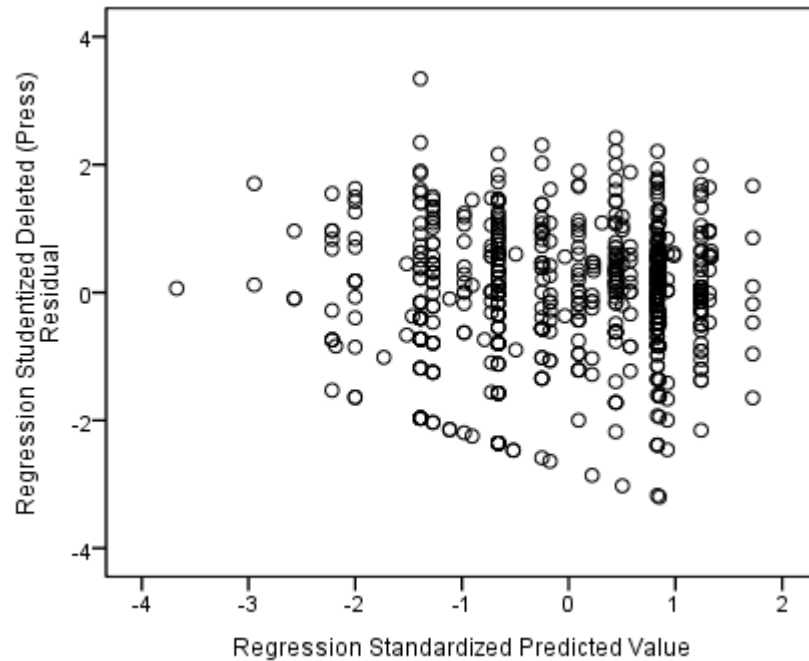


Figure 19: Residuals Variation Plot

4.5.2. Interpreting the results

The R^2 obtained by the model indicated that the variables incorporated in its regression equation account for 23% of the variability in \log_{10} (ALC), and hence in ALC days themselves. Normally higher values of R^2 are better. However, for the sake of the particular scenario of understanding the factors contributing to ALC, the remaining unexplained 80% points to a very important discovery; that considerable variability lies in other factors that have not been considered here. Those factors might be:

- The severity of patient's illness
- The efficiency of the social work department
- Patient financial status, and more importantly...

- Factors that lie within the hands of the alternate level of care institutions; making them outside the scope of the hospital. Important considerations for this can be:
 - The number of available beds in the most appropriate choice of receiving facility and nature of flow of their residences.
 - The availability of medical equipment to be sent to the patient's home.
 - The availability of resources (nurses and others)
 - Their preparation in terms of forecasting for incoming demand and the measures taken to accommodate it (or the lack of).

On the other hand a P-value of 0.000 for the ANOVA test signifies that the variables entered in the model are in fact true contributors to the 23% explained variability. They are all directly related to the hospital experience and are worth exploring. From Table 14 the p-values for all the variables are significant, indicating that all of them are again true contributors in explaining ALC days. The high tolerance values (away from 0) imply that the variables are not dependent on each other and do not cause inflation in the R^2 due to co-linearity issues.

Table 14 also explains the structure of the regression equation and the degree of contribution to ALC days by equation coefficients. Naturally negative coefficients are pushing the value of the dependent variable down, and positive ones increase ALC days. Even though the equation is reported by the B coefficients, the Beta (β) coefficients are rather the measure of comparison between the variables (since they are the standardized values).

The equation obtained by this model is the following:

$$\begin{aligned} \log_{10}(ALC) = & 1.013 + 0.313 (LTC) + 0.231 (CCC) - 0.327 (TEL) + 0.158 (Rehab) - \\ & 0.632 (6W) - 0.153(CCAC) - 0.129 (6E) + 0.086 (2N) - 0.102 (none \\ & senior/senior) \end{aligned} \quad \dots \text{(eq. 3)}$$

According to the model, LTC, CCC, and Rehab institute types and 2N medical unit, contribute to elevated ALC days. A sign of where possible improvement efforts should be directed first, and an indication that the problem is mainly related to the institutions.

Usually medical units have many people waiting long ALC days (with the exception of the telemetry unit). In previous Med/Surg comparisons, it was combined with the medical group since it is in fact considered as a unit providing cardiac medical services. However, when separating medical units from each other ALC days are radically less in telemetry and neurology units (illustrated in Figure 20). Although not a rule, it is likely that when most patients do not wait ALC days, the ones that do would wait for short periods. This was highlighted by the results of the regression model by giving TEL a strong negative coefficient.

Surgical units were also mentioned to have lower ALC patients and ALC days; another characteristic incorporated in the model equation with negative coefficients. The negative coefficient for none seniors/seniors meant that younger patients- when appointed the ALC status - waited longer than seniors. This however should not be confused with the fact that about 90% of ALC awaiting patients are above 65 years of age.

Not to forget about the rest of the variables that did not contribute to the model equation but had some correlation to $\log_{10}(\text{ALC})$, the correlation results in Table 15 will now be interpreted. Significant positive correlations existed for 7E, NEU and Acute care days. So being in either units and having longer acute care days would result in elevated ALC days. And since the reference variables were Unit NSX and Institute Mental Health, and then the latter interpretation can be said in comparison with those references. The correlation of support care was inverse, as it was for CCAC, and since they are technically similar groups or patients (as explained previously) the results here do make sense.

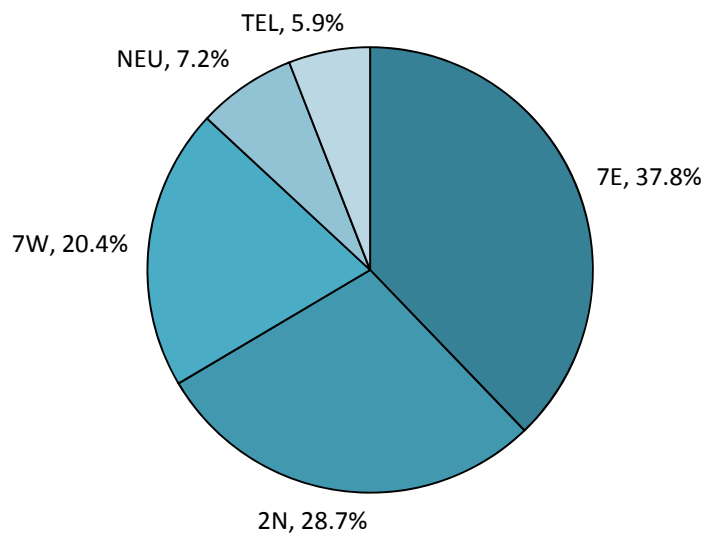


Figure 20: Pie Chart of %of ALC Patients between Medial Units

Having significant R^2 , correlations and coefficients are not enough to conclude that the regression model is sound. Residuals are the deviations of the observed (actual) values from the (model) linear equation resulting values. They are very important in checking for

the validity of the model. As linear regression assumes the normality at the univariate level of all continuous variables (whether dependent or independent), it also assumes that the residuals should be normally distributed and have equal variation along the equation line. Figures 17 and 18 easily show that the residuals from the model do not violate the normality assumption. Figure 19 shows a scatter diagram demonstrating that the variability negligibly converges to the right, and does not violate the constant variability assumption.

4.6. Logistic Regression Analysis (Likelihood of Awaiting ALC)

Since the hospital is currently facing prediction issues, problems (mentioned in section 3.5) presenting the lack of daily accuracy of discharges, large deviations between expected length of stay and actual length of stay, and the contribution of ALC days to those problems, it is worth examining who is likely to wait ALC days, and who is likely to leave right after the end of their acute care days. This section explains the likelihood of waiting ALC depending on certain factors. It is worth mentioning that the data is not a subsample, all of the 1740 patients were included, as opposed to the linear regression model that excluded the patients that were sent home without any services, and only included the 644 patients that waited ALC days.

To be able to run this type of analysis the continuous variable ALC days was transformed to a categorical variable Cat(ALC) with two groups: 'No ALC patients' (ALC days =0), and 'ALC patients' (ALC days >0). The logistic regression model was set up as follows:

- Dependent Variable : Cat(ALC), does not need to meet any assumptions

- Independent Variables: Gender, $\text{Log}_{10}(\text{Acute days})$, None seniors/Seniors, Unit 2N, Unit 6E, Unit 6W, Unit 7E, Unit 7W, Unit NEU, Unit TEL (Unit NSX was the reference), Inst Acute, Inst CCAC, Inst CCC, Inst LTC, Inst Rehab, Inst. Support Care (Inst MH was the reference) and home (no services required).
- A Forward Stepwise approach; the stepwise selection of significant variables that contribute most to the presence of ALC days and the lack of.

4.6.1. Logistic Regression Results

The model was significant with an R^2 between (0.354, 0.481) as shown in Table 16, this is backed up by the results in Table 17. The list of included variables was; non-senior, senior), Units 2N, 6E, 6W, 7E, 7W, NEU, Institutions CCC, LTC, Rehab, Support Care and Home. The remainder of the variables were not significant. Predictability of the model is explained in Table 18, and the model parameters are listed in Table 19.

Table 16: R^2 and Hosmer and Lemeshow Test Results for Logistic Regression Model

-2log Likely hood	R^2	Chi-square	df	P -Value
1551.258	(0.354 - 0.481)	4.024	8	0.137*

* Using a two-tailed $\alpha = 0.05$

Table 17: Contingency Table for Hosmer and Lemeshow Test

Cat(ALC) = No ALC		Cat(ACL) = ALC		Total
Observed	Expected	Observed	Expected	
167	167.3	5	4.7	172
91	90.0	5	5.6	96
177	182.0	24	19.0	201
180	170.0	22	31.7	202
135	126.9	33	41.1	168
120	128.5	66	57.5	186
85	94.1	79	69.9	164
63	61.2	102	103.8	165
33	35.0	130	128.0	223
28	23.3	195	199.7	

Table 18: Classification Table

		Predicted		
		Cat(ALC)		
Observed		No ALC	ALC	Percentage Correct
Cat(ALC)	No ALC	949	130	88.0
	ALC	216	445	67.3
	Overall Percentage			80.0

Table 19: Included Variables and Their Odds Ratio

Variables	B	Std. Err	Wald	df	Odds Ratio	95% CI	
						Lower	Upper
None senior/Senior	0.621	0.181	11.754	1	1.861	1.305	2.653
Unit 2N	1.35	0.181	56.03	1	3.866	2.714	5.509
Unit 6E	-1.174	0.519	5.125	1	0.309	0.112	0.854
Unit 7E	1.792	0.176	103.532	1	5.999	4.248	8.472
Unit 7W	1.425	0.198	52.013	1	4.158	2.823	6.124
Unit NEU	0.951	0.268	12.614	1	2.589	1.532	4.376
Inst CCC	3.221	0.297	117.556	1	25.034	13.987	44.807
Inst LTC	2.586	0.196	174.302	1	13.283	9.048	19.501
Inst Rehab	0.789	0.210	14.14	1	2.201	1.459	3.321
Inst Support Care	1.467	0.169	75.365	1	4.335	3.113	6.036
Home	-0.946	0.286	11.44	1	0.384	0.219	0.674
Constant	-2.881	0.214	181.156	1	0.056	-	-

* Using a two-tailed $\alpha = 0.05$

4.6.2. Interpreting the results

In logistic regression it is not possible to obtain a single defined R^2 , but rather some approximations for it that might give different results according to the method used. The result of the model says that it explained between 35.4% and 48.1% of the variability in Cat (ALC). Again here some other factors not considered by this analysis turned out to have an effect on whether a patient waits ALC days or not. However the p-value result of 0.137 (> 0.05) for the Hosmer and Lemeshow test shows that the selected variables are in fact true contributors to the approximate 42 % explained variability, and are worth exploring. The Hosmer and Lemeshow test generally runs 10 groups of scenarios for the model and compares the observed (model) generated results with the expected (true

results), and that is how the performance of the model is measured as was shown in Table 17.

From Table 18, one can deduce that the correct results will be obtained by the model about 80% of the time. Meaning that it will correctly predict that a patient did not wait ALC days - when in reality they truly did not wait - 88% of the time, and it will correctly predict that a patient waited ALC days - when in reality they truly did wait - 67% of the time.

Now that it is known the model works, it is time to explore the effect of each of the variables. Table 19 shows that all the included variables were significant. This is known by looking at the 95% confidence intervals of the odds, if 1 was included between the range of lower and upper values then this variable is not significant, since 1 means the probability of being ALC and being no ALC are the same. When significant the Odds Ratio represents the ratio-change in the odds for a one-unit change in the variable for continuous variables. As for dichotomous variables, this value is easier to interpret.

The Odds Ratio for none senior/Senior of 1.861 means that the probability of a patient 65 years of age or older to wait ALC days is 1.861 times the probability of a younger patient awaiting ALC days. Put in simpler words, older patients are twice more likely to wait ALC days than patients with less than 65 years of age when holding all other factors constant.

The same interpretation approach can be used for all other entered variables (but in comparison with the reference variable) as follows:

- The odds of waiting ALC days are 3.8 times more likely for a 2N patient compared to a neurosurgical patient (the reference).
- The odds of waiting ALC days are, 6.0 and 4.2, 2.5 times more likely for 7E, 7W and NEU patients (respectively) compared to neurosurgical patients respectively.
- The odds of waiting ALC days are 0.3 times less likely for a 6E patient compared to a neurosurgical patient.
- The odds of waiting ALC days are 25, 13.3 2.2 and 4.3 more likely for patients to be sent to CCC, LTC, Rehab, or Support Care respectively when compared to patients sent to a mental health institution (the reference).
- The odds of waiting ALC days are 0.3 times less likely for a patient to be sent home (without support) compared to a patient sent to a mental health institution.

In other words, it is for example very likely for a senior patient from the unit 7E, going to complex continuing care (CCC) to wait ALC. However, it is much less likely for younger patient coming from unit 6E going home to wait ALC days. The diagram in Figure 21 illustrates the likelihood of waiting ALC days depending on the aforementioned variables.

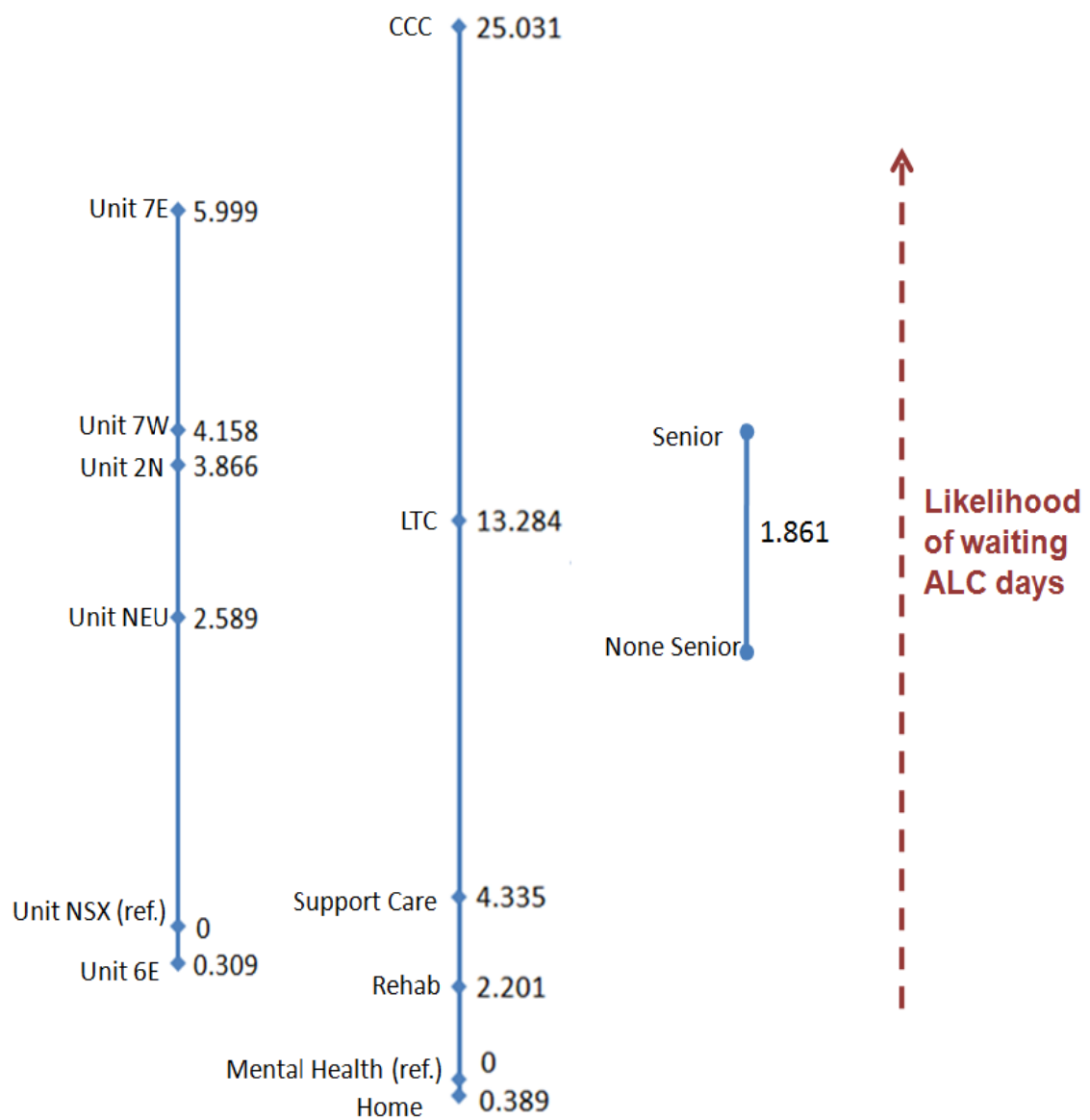


Figure 21: Likelihood of Waiting ALC days

CHAPTER 5: SIMULATION OF DISCHARGE PLANNING AND REDUCING LOS

5.1. Introduction

The discharge planning process is currently extending beyond the acute care days of patients resulting in Alternate Level of Care days and an increased length of stay. Even though the reasons of ALC days mainly lie outside the hospital due to unavailability of resources to accommodate those transitioning patients, the question worth asking here is; what can the hospital do in terms of discharge planning to reduce length of stay. This question cannot be answered unless the following question is answered first: how exactly is the discharge planning process currently performing to generate the historically observed LOS. Only when this is understood, certain recommendations can be laid out.

Simulation modeling can be a tool for comparison between the current situation and the recommended one in this case. Analyses of the discharge planning activities should be done in order to create the closest possible model to reality. Afterwards, the recommendation will be modeled accordingly.

A pre-existing intervention that was put in place to improve patient flow is the Red-Yellow- Green light initiative. This paper was set to explore whether this intervention was beneficial. The last section of this chapter includes the analysis done to answer this speculation.

5.2. Simulation of Discharge Planning

5.2.1. Data Collection and Model Structure

According to the regression analysis, the most persistent category of patients contributing to ALC days were ones requiring placement in long term care (LTC), accounting for almost half of the patients awaiting ALC days and leaving the rest for the 6 remaining institutions. Again, patients from medical units 2 North, 7 East and 7 West are sent to LTC more frequently than other units and this is represented in the pie chart of Figure 22. Therefore, from the same population of patients used in the previous analyses of ALC days, the sample of data collection was chosen from institution type LTC, and units 2N, 7E and 7W.

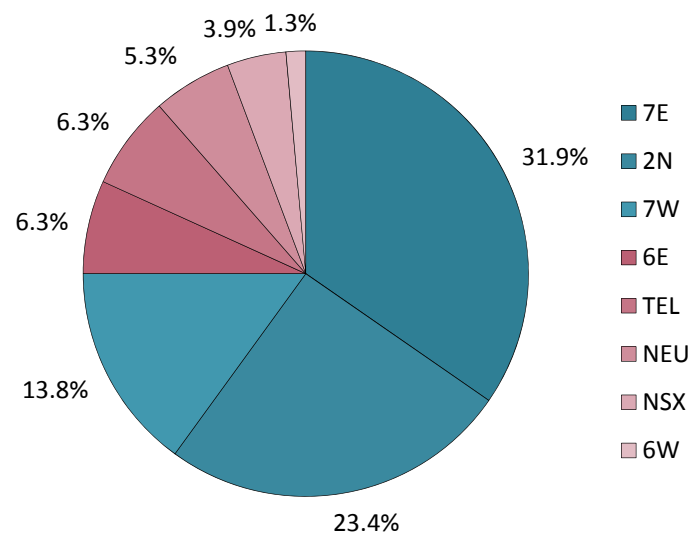


Figure 22: Pie Chart of Percentage of Patients Going to LTC

The model was structured in a way similar to the sequence of events of discharge planning that are illustrated in the flow chart in Figure 23. The path of discharge planning was simplified since the data collection process is tedious in that it was painstakingly pulled out manually from rather complicated patient charts (paper documents). The structure of the model is shown in the patient episode with the considered time stamps illustrated in Figure 24.



Figure 23: Simulation Model Path

A list of activities occurs between each of those time milestones. The abbreviations that will be used in this section for each of the intervals and the most important activities that occur in them are as follows:

- Admission to Referral to social work (**Adm-RefSW**): the start of acute care and the functional assessment resulting in referral to social work.
- Referral to social work to Involvement of social work (**RefSW-InvSW**): wait time (while still receiving acute care) between the referral and the actual acknowledgement of it by social work to follow up with the patient for discharge planning
- Involvement of social work to Sending LTC placement application (**InvSW-AppI**): time taken to decide on the best course of action to fulfill patient needs in terms of discharge destination. This period includes a series of meetings with the patient to reach to an agreeable destination (LTC in this case). The importance of

the “Application sending” milestone lies in the fact that the patient will not be placed on the waiting list of the chosen LTC facility until the application is completed and sent.

- Sending Application to Discharge (**Appl-D/C**): this phase is technically the placement application processing time. At a point in time in between, the patient stops receiving acute care and is given the ALC status. Social work would be in close contact with the mediator; Community Care Access Center CCAC to continuously for availability in the chosen LTC facility.

5.2.2. Current State Model

In order to identify the nature of phases of the model, the date for each milestone was recorded and the number of days between each of the dates was calculated. A total sample of 152 patients charts were reviewed and for each phase. ProModel (Ver.7) was used as the simulation tool, and in order to identify the inputs of the model, a probability distribution for each of the intervals had to be identified.

The data did not resemble a normal distribution under any of them due to high kurtosis and skewness, therefore further testing was necessary. Minitab (Ver.15) was chosen for this task as it has the option of running tests of all possible continuous variable distributions at once. The software uses an Anderson Darling test, which tests whether the given data fit the tested distribution or not. A P-value larger than 0.05, indicates that the test is significant. The AD statistic allows the comparison between several matching distributions, with the lowest value indicating the best fit. It is always worth remembering

here that the main target is to achieve a model that is close enough to reality to allow a valid comparison; that is results that resemble the actual LOS distribution.

The results of the distribution identification tests are summarized in Table 20. Bolded values are ones that indicate that the corresponding distribution matched the data.

ProModel has built in functions for all those functions except for logistic distribution; the user would only need to enter the parameters. The most appropriate option was selected based on the AD value and the availability of the function in ProModel. The shaded values in Table 20 resemble the selected distributions.

It can be observed from the results that no probability distribution matched data from the intervals; Ad- RefSW, RefSW - InvSW for any of the units. Some options were identified for InvSW - Appl for only unit 7W. Assuming the character of any of the distributions incorrectly would create a discrepancy in the results. Therefore, to deal with this issue - the lack of representative probability distribution - it was decided to embed a function in the model that allows it to literally “read” data from a spreadsheet containing the actual historical data. Three spreadsheets were prepared for the three types of intervals for each of the units (including InvSW - Appl from 7W for consistency), and a READ (File, <name>) function was installed in the model to enable accurate input. As for the interval Appl-D/C, the probability distributions were inputted as follows:

- 2N : W(1.198, 21.4)
- 7E: L(19.61, 18.74)
- 7W: L(18.26, 17.94)

Table 20: Distribution Identification Results for Intervals

		Possible Distributions													
Unit	Interval	Logistic		S.E.V.*		L.E.V.**		Gamma		Exponential		Weibull		Lognormal	
		AD	P-value	AD	P-value	AD	P-value	AD	P-value	AD	P-value	AD	P-value	AD	P-value
2N	Ad-refSW	3.18	<0.005	7.19	<0.01	2.47	<0.01	-	-	-	-	-	-	-	-
	refSW-InvSW	4.65	<0.005	11.70	<0.01	4.20	<0.01	-	-	-	-	-	-	-	-
	InvSW-Appl	1.35	<0.005	4.40	<0.01	0.70	0.065	-	-	-	-	-	-	-	-
	Appl-D/C	1.30	<0.005	6.96	<0.01	0.61	0.108	0.48	>0.25	1.19	0.07	0.47	0.239	0.56	0.134
	LOS	1.28	<0.005	4.97	<0.01	0.48	0.23	0.60	0.14	5.85	<0.003	1.19	<0.01	0.30	0.58
7E	Ad-refSW	5.98	<0.005	10.56	<0.01	5.04	<0.01	-	-	-	-	-	-	-	-
	refSW-InvSW	6.99	<0.005	13.62	<0.01	6.85	<0.01	-	-	-	-	-	-	-	-
	InvSW-Appl	2.47	<0.005	12.08	<0.01	1.52	<0.01	-	-	-	-	-	-	-	-
	Appl-D/C	3.64	<0.005	9.20	<0.01	2.46	<0.01	1.35	<0.005	2.21	0.005	1.54	<0.01	0.57	0.13
	LOS	1.52	<0.005	5.71	<0.01	0.47	0.24	0.46	>0.25	7.42	<0.003	0.99	0.01	0.36	0.45
7W	Ad-refSW	0.81	<0.005	2.34	<0.01	0.70	0.06	-	-	-	-	-	-	-	-
	refSW-InvSW	1.99	<0.005	4.55	<0.01	1.76	<0.01	-	-	-	-	-	-	-	-
	InvSW-Appl	1.21	<0.005	1.65	<0.01	0.89	0.20	0.44	>0.25	0.76	0.22	0.48	0.23	0.42	0.32
	Appl-D/C	1.13	<0.005	3.79	<0.01	0.66	0.08	0.38	>0.25	0.79	0.20	0.48	0.23	0.14	0.90
	LOS	0.99	0.006	2.31	<0.01	0.59	0.12	0.601	0.132	3.47	<0.003	0.85	0.03	0.35	0.45
LOS all units		3.43	<0.005	12.65	<0.01	1.06	<0.01	1.18	<0.005	16.49	<0.003	2.62	<0.01	0.49	0.22

* Smallest Extreme Value Distribution **Largest Extreme Value distribution

Other important inputs to the model are the probabilities of sending each patient to each unit, since in reality the three are not equal in sending patient to LTC. From the sample it has been deduced that 32.9% were from 2N, 49.3% and 17.8% were from 7E and 7W respectively. An illustration of the model with its inputs and outputs is shown in Figure 24. The goal to be achieved here is to get outputs that are similar to the actual (historical) lengths of stay of patients from the different units, and for LOS of all together as a group. Table 20 also has the distribution identification results of the LOS variables.

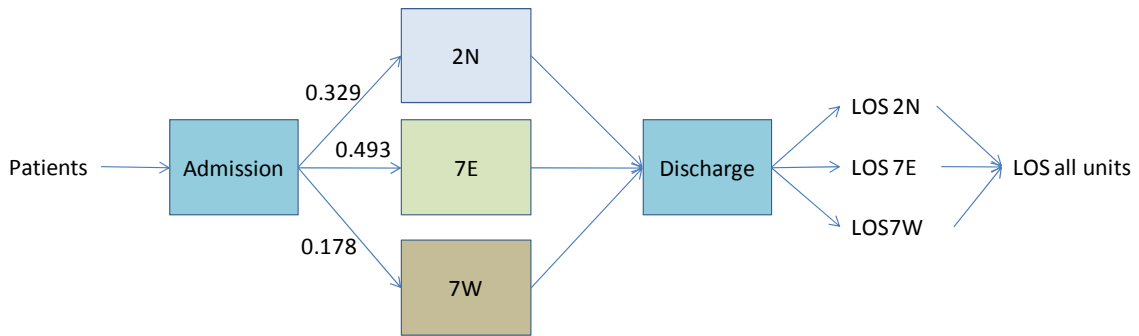


Figure 24: Simulation Model Inputs and Outputs

The lack of understanding (or specific distribution identification) of data under the process intervals Ad- RefSW and RefSW - InvSW, implies that there is inconsistency in the time taken to complete the tasks within these phases. The time between the referral of social work to the involvement of social work is practically and theoretically a delay in the discharge process, and efforts should be expanded to minimize this delay as much as possible.

As for the time between admission and referral to social work: it is a matter that has already been addressed in literature and discharge planning books. They all call for early planning. Many say that it should start as early as admission. The performance of both processes Ad - RefSW and RefSW - InvSW was examined using control charts generated by Minitab (Ver15), by setting the specification limits to 0-3 days for referral to social work, and 0-2 days for involvement of social work after referral.

The control charts for 2N in Figures 25 and 26 showed little deviation from the upper limits of 2 and 3 days, however for some patients they did exist. As for the charts from 7E and 7W the deviations are radical; as seen in Figures 27-30.

5.2.3. Model Validation

The model was run for a sample of patients equal in volume to the sample size; 152. The results showed a significant resemblance to the distribution of actual LOS. However, to check that the model is able to perform well on any number of patients, replications of quadruple (608) the sample size was inserted and the performance of the model did not change. A comparison between the actual distributions of lengths of stay and distributions of simulated lengths of stay is shown in Figures 31 and 32.

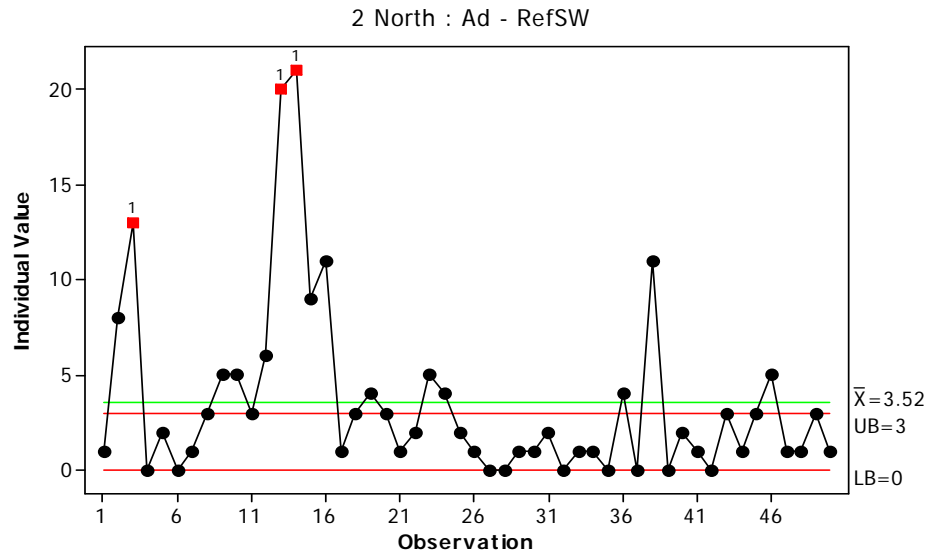


Figure 25: Process Control Chart for Ad-RefSW of 2N

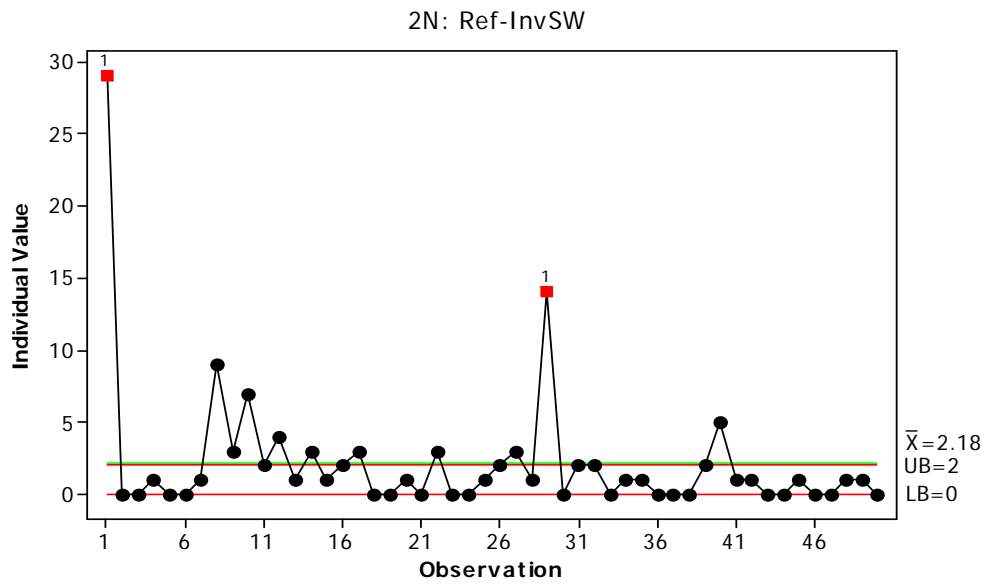


Figure 26: Process Control Chart for RefSW-InvSW of 2N

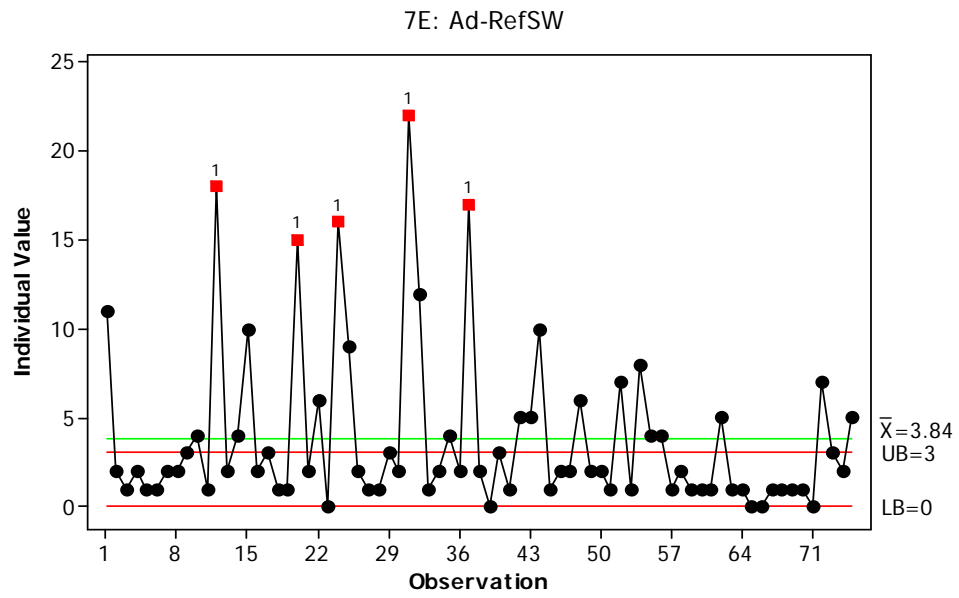


Figure 27: Process Control Chart for Ad-RefSW of 7E

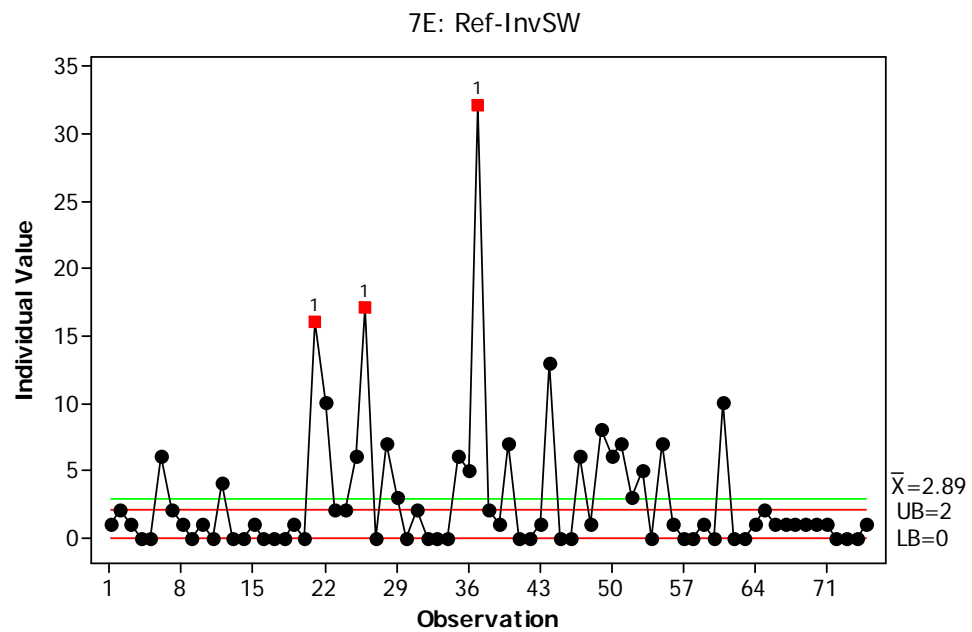


Figure 28: Process Control Chart for RefSW-InvSW of 7E

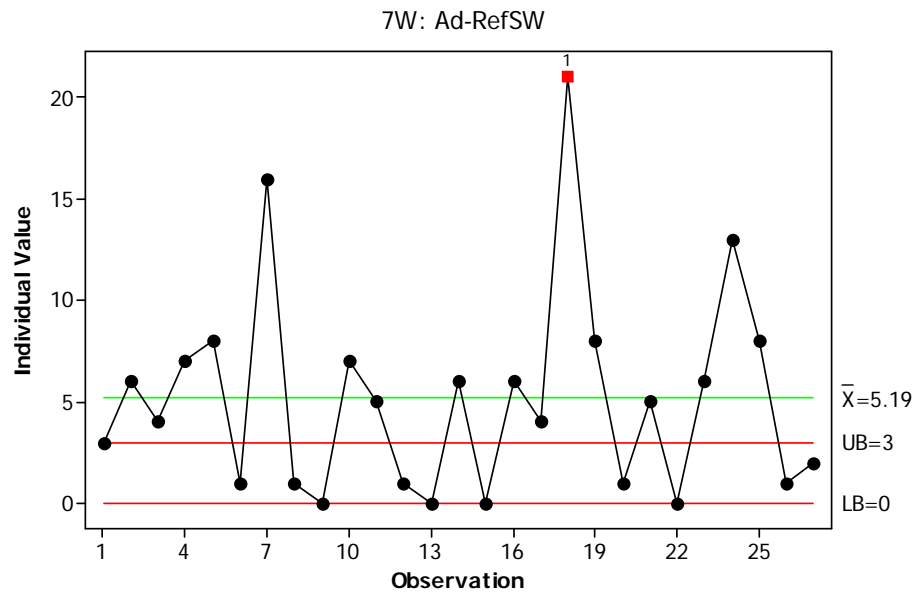


Figure 29: Process Control Chart for Ad-RefSW of 7W

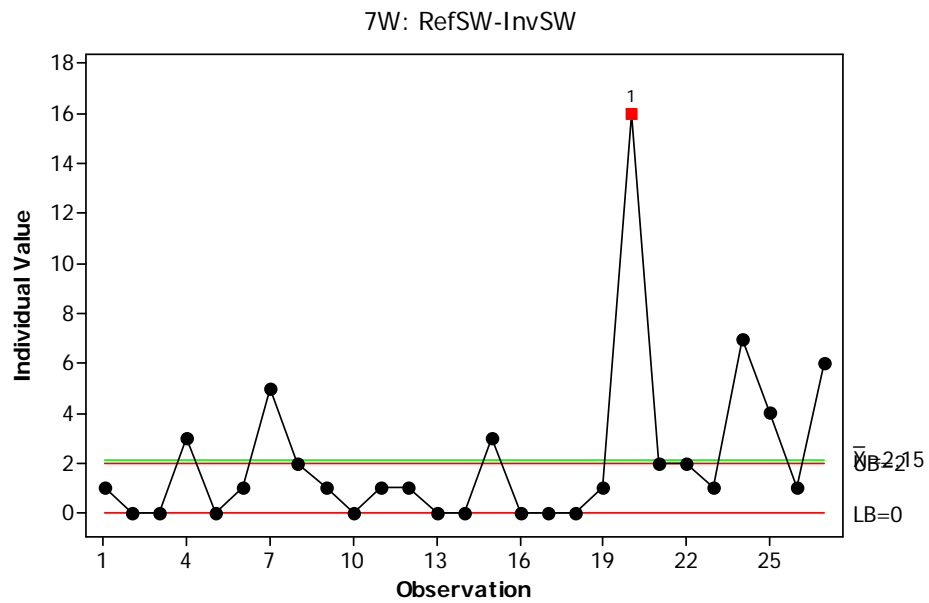


Figure 30: Process Control Chart for RefSW-InvSW of 7W

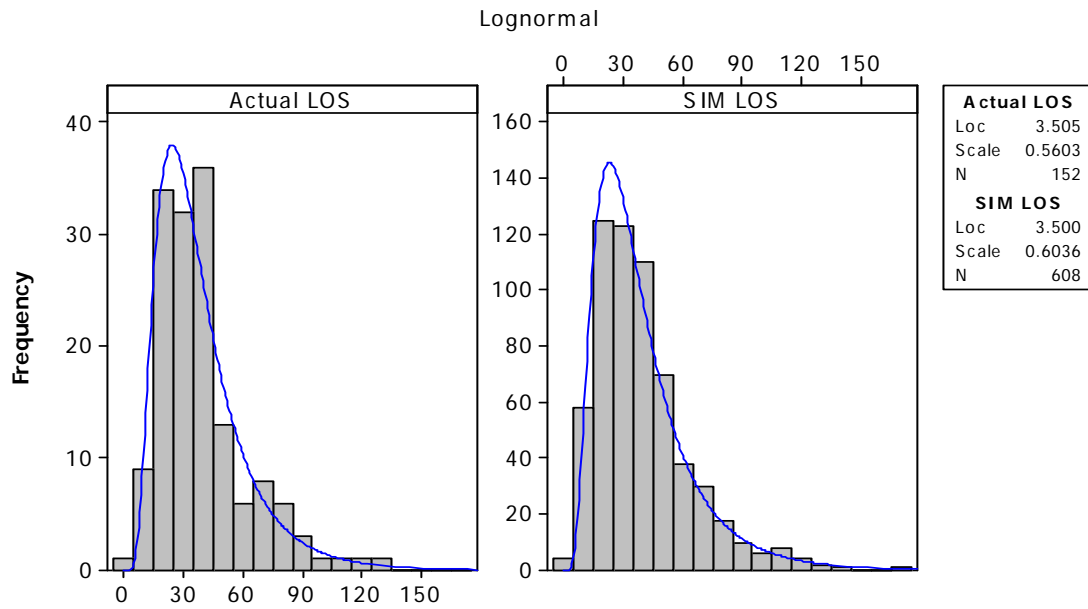


Figure 31: Comparison Between Actual LOS and Simulated LOS for All Patients

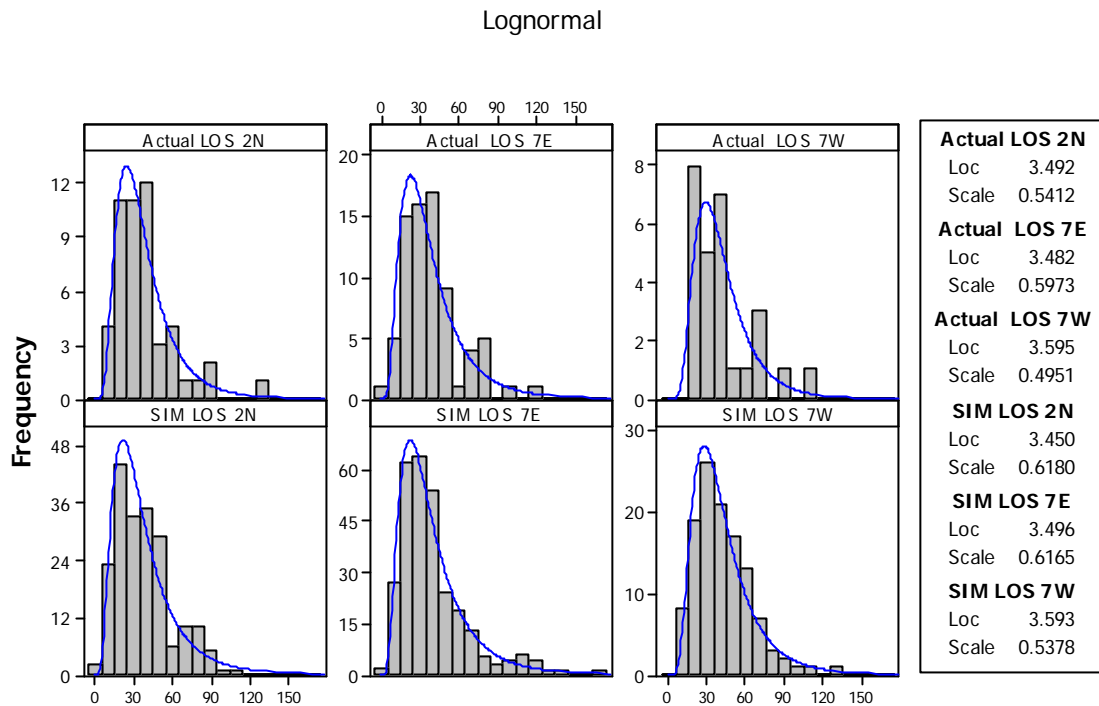


Figure 32: Comparison between Actual LOS and Simulated LOS for the separate units

5.2.4. Future State Model (What-if Scenario)

Section 5.2.3 mentioned that the time between the referral of social work and the actual start of discharge planning is in itself a delay. For the patient it is a non value added time that might not be effective at that moment (since the patient would be receiving acute care), however it can add to the delay in discharge and cause more ALC days. The same can be said for the first interval, Adm - RefSW. In order to be able to detect the need for planning, many efforts have been put to create accurate checklists and questionnaires that when answered, provide a score indicating the necessity of referral. The hospital itself has early planning (from admission) emphasized in the responsible resources' job descriptions (recall Section 3.1). This implies that this interval should be zero days.

Since the hospital is running at high capacities, it is sensible to assume that there is quite a lot on the nurses and social worker's hands that a drastic improvement from the current performance to zero or 1 day intervals might be unrealistic. However, as almost already being done in 2N, it is worth testing the effect of a what-if scenario saying; what if the time between admission and referral to social work was between 0 and 3 days, and the time between the referral of social work and the actual start of discharge planning was between 0 and 2 days?

In order to answer that question, the current state model has to be modified. The way this can be done is by creating two new spreadsheets of values for both intervals, and having the model read those new values as opposed to the ones that showed the current state. To keep a random effect on the model the new files were prepared in such a way that:

- Integer numbers between 0 and 3 inclusive are randomly generated and listed for the time to referral according to a 0.25 probability of occurrence of each number.
- Integer numbers between 0 and 2 inclusive are randomly generated and listed for the time to involvement of social work after referral according to a 0.333 probability of occurrence of each number.

The new model with the aforementioned characteristics was run keeping the InvSW-App and Appl-D/C characteristics the same as in the current state model. Those last two intervals are shaped by many variables that might need a separate project by itself for the ability of making valid interventions. Some of those factors can be:

- InvSW - Appl. incorporates ongoing series of discussions that might be complicated by the nature of the patients illness and social status such that the decision making process of discharge destination can be largely influenced. Another impact is the patient's personality and judgement ability in cooperating with the social workers.
- Appl - D/C is - as has been said before- the application processing time, which is mainly shaped by the performance of CCAC alongside the status of availability in LTC facilities.

Both reasons indicate that adjusting what happens within those two intervals is a challenge by itself and is out of this project's scope, and can be addressed in future work. Also, it is worth mentioning that the model assumes that processing times for LTC placement have not changed.

5.2.5. Resulting Improvement

After running the what-if scenario, the results showed promising improvement in length of stay. As shown in Figures 33-36, the slight shift (dashed line) - to the left - of all the distributions indicates that more people are staying for less time at the hospital. The slight difference in improvement between unit 2N and both 7E and 7W is due to the fact that efforts are already in place to help early discharge planning in 2N; an effect also visible in the control charts of section (5.2.2) when comparing 2N to the other units.

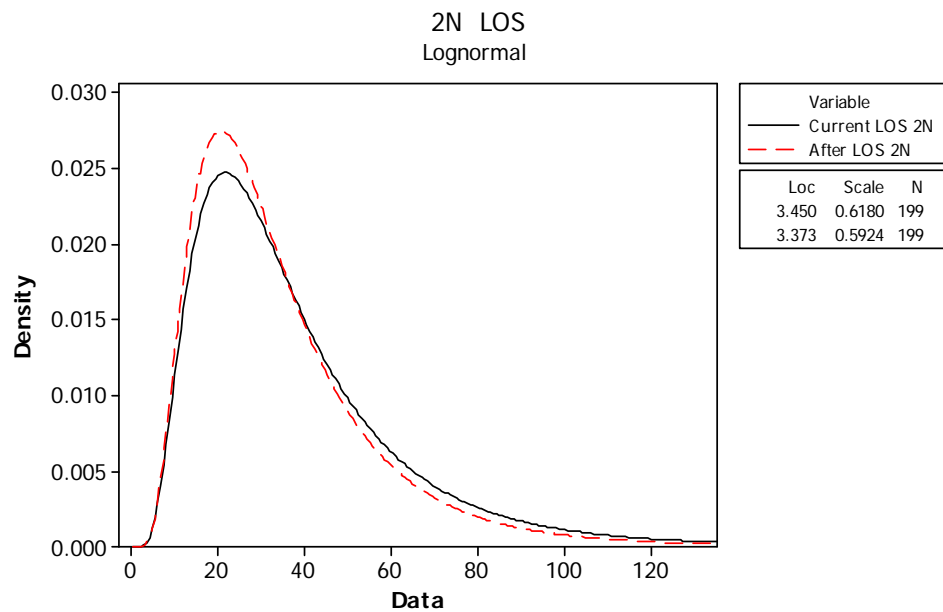


Figure 33: Improvement on LOS in 2N

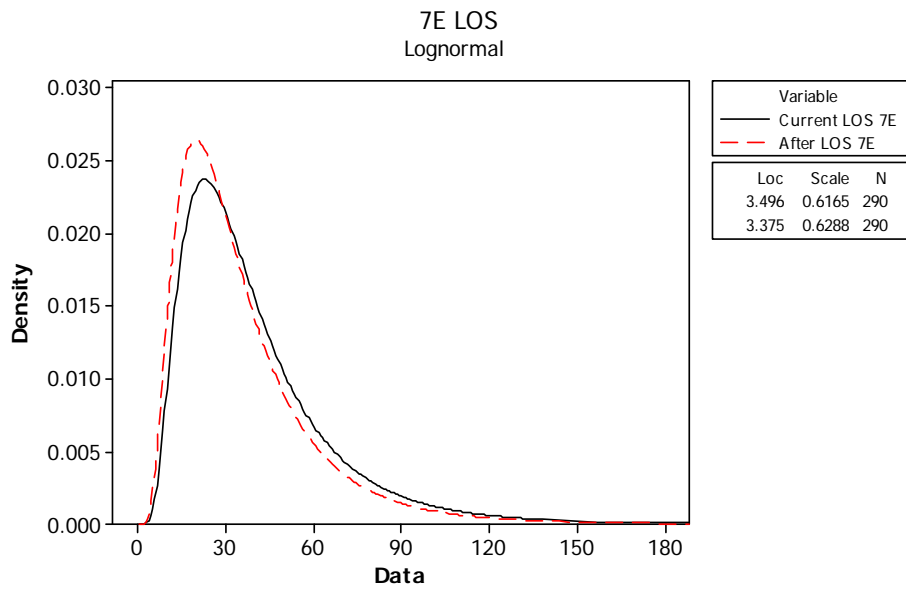


Figure 34: Improvement on LOS in 7E

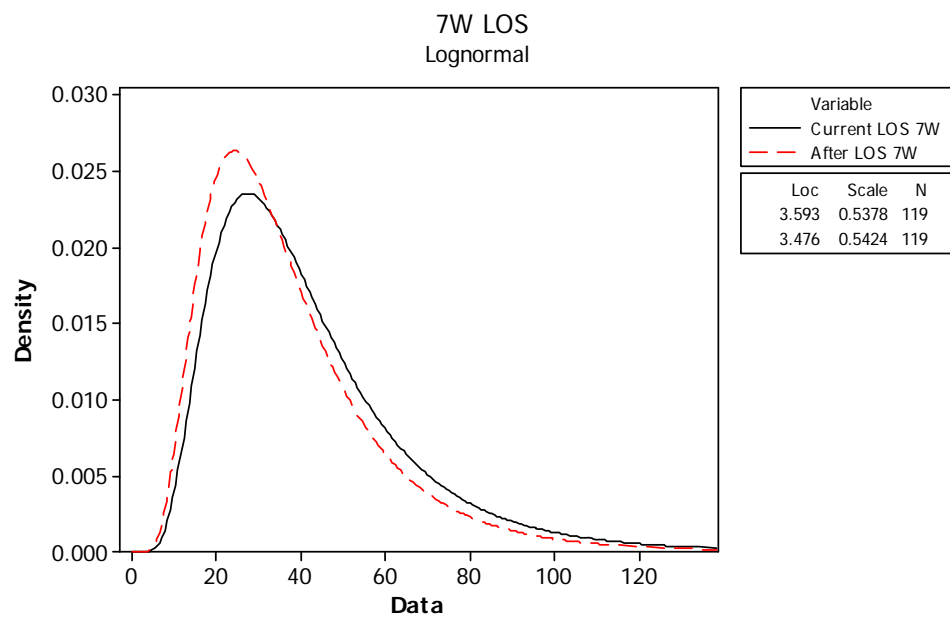


Figure 35: Improvement on LOS in 7W

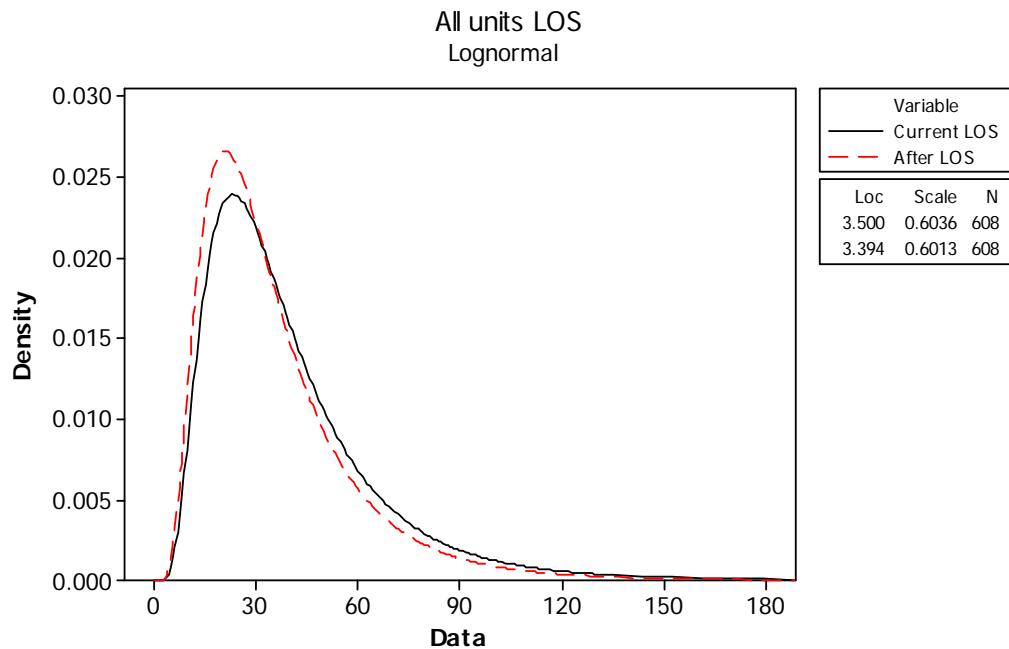


Figure 36: Improvements of LOS (Three Units Combined)

In order to quantify this improvement, a test was conducted to see whether the before and after (current vs. after ‘what-if’ scenario) data (from combined units) are statistically significantly different. Since the distributions resemble nonparametric data, Mann Whitney U was used to test for the difference in medians. The test results are shown in Table 21, demonstrating that the difference between the samples is not due to chance, and an improvement of 4.5 days can be deduced. Translated into dollar values, the savings were $\$3,146,400 - \$2,736,000 = \$410,400$ (13%) for the 152 LTC patients. On average, it accounts for savings of \$214,121 per year (\$17,843 per month).

Table 21: Man Whitney Test Results for Before and After Improvement

Variable: LOS	Mean	Std. Dev.	Median	Man Whitney Test	
				Z	P-Value
Before	38.73	22.52	34.5	-2.194	0.028*
After	35.27	22.39	30.0		

* Using a two-tailed $\alpha = 0.05$

5.3. Assessing the effect of RYG-light Initiative on Patient Flow

Recalling from Sec 3.7, medical units 7E, 7W and 2N were used for an ALC days' comparison between before and after the implementation of RYG-light. The data for the three units dates from discharges that happened between April 2007 and February 2009. The initiative did not start at the same time the three units and that was taken into consideration when ruling data points in the 'before' group as opposed to the 'after' group. Also the month that the initiative started at each unit, and the month after that were discarded from the comparison since they were believed to be transitional periods of the initiative and it was still on the way of being implemented to all patients.

Since ALC days data (with the Zero values; no ALC) does not resemble a normal distribution, the before and after comparison was done using the Man Whitney Test. The result is shown in Table 22 indicating that the test is significant; before and after values are not the same, and that the reduction in the median of ALC days is not due to chance. The savings incurred from this initiative cannot be directly calculated by the sample sizes in the table, since for some units it started earlier than others. Therefore, by calculating the number of patients before and after for each unit separately, dividing that by the

corresponding number of months in the before and after phases, and considering the cost of \$600/night and the following results were obtained:

- For 7W: before = \$25,573/month, after = \$14,796/month
- For 7E: before = \$42,473/month, after = \$18,798/month
- For 2N: before = \$40,091/month, after = \$17,100/month

Total savings for the three most ALC contributing units = 107,037-50,694
 =\$56,343/month

Table 22: Man Whitney Test for Before and After RYG-Light

Variable: ALC days	N	Mean	Std. Dev.	Median	Man Whitney Test	
					Z	P-Value
Before	570	12.12	18.35	5	-2.048	0.041
After	198	9.5	15.91	2		

* Using a two-tailed $\alpha = 0.05$

The alarming red color drives the healthcare professionals (nurses, social workers, and others) to be conscious of the persistent need of some service. The goals of the nurses, physicians, physiotherapists, etc. would be to help treating the patient's ailment to transition them to the yellow and then green status. The yellow status for the family means that they should prepare to pick the patient up after 3 days and make sure that everything they need is set up at home (or elsewhere). The goal of the social worker would be to see that the patient is actually leaving the day after they get the green status, and not see the blue sign hung up by their bed indicating ALC. While the patient is 'red', all the discharge planning steps should be accomplished and as the previous section

explains; the sooner the better. Being very clear and visual, the signs eliminate the risk of having a misunderstanding between the healthcare professionals, and the patients as well.

CHAPTER 6: RESEARCH CONCLUSIONS AND RECOMMENDATIONS

The discharge process at a hospital consists of a complicated list of events that has to be run in parallel with the treatment process. Theoretically, for patients that require extended discharge planning, social workers are responsible for walking the patient through the discharge path. Other resources (such as nurses) though mainly present to care for the patient's wellbeing should also think in terms of the efficiency of patient flow so that other incoming patients' wellbeing is not at stake. In studying the discharge process and its affect on hospital predictability of patient flow, the research project revealed important concerns. The hospital has problems in several aspects of the discharge process, and the study sought to analyze them all in order to reach to proper solutions and meaningful recommendations. The list of quantitatively identified problems included:

- a) The discharge process and the discharge planning process were neither clearly defined nor understood in terms of structure and sequence.
- b) The accuracy of predicting daily discharges was only about 50%, creating a mismatch between the discharges and the admissions that were to happen any particular day.
- c) The expected lengths of stay of patients deviate considerably from their actual length of stay creating another long term planning problem.
- d) The existence of the extensive delay of alternate level of care (ALC) days between the periods of April 2007 to February 2009. Other problems caused by ALC days were:

- i. Their association with decreasing the accuracy of predicting daily discharges, being more present among medical rather than surgical patients.
 - ii. Their association with increasing the deviation between ELOS and LOS.
 - iii. The radical incomprehensible variation in the length of ALC days, and the consequent aggravation of the previous problems.
- e) Inconsistent and lengthy times are taken to decide that social workers should get involved, and for social workers to actually start with the discharge planning process after the referral.
 - f) The Red-Yellow-Green Light Initiative's affect in improving ALC days was not clearly known or confirmed.

The previous information directed the research to a very important conclusion. This conclusion was actually initiated by the following questions: how can the hospital flow be improved without knowing how the flow is running? How can flow be measured if it depends on ALC days when the characteristics of ALC days are not clearly understood? While this is the case, improvements are not quite possible. However, efforts have to start somewhere to understand the contributors to ALC days and the probability of actually waiting those days.

The linear regression analysis results indicated that generally medical patients wait longer than surgical patients, especially if they had to be sent to long term care or complex continuing care facilities. Not only that, the same variables here were also important to the logistic regression model that was run for the same data. The likelihood of a patient

awaiting any number of ALC days is higher for older patients, being treated in 2N, 7E or 7W medical units and require placement in either LTC or CCC. So not only having those characteristics increases one's odds of waiting beyond acute care, they also generate long wait times as opposed to other characteristics.

The reason medical patients might stay longer is because they are most likely to be older (75 years of age and above) with multiple chronic conditions, and are very likely to require long term care and complex continuing care placements in particular. The linear regression model indicated that when none-seniors waited ALC days, they waited a bit longer than seniors. Two reasons for this can be:

- a) Those patients were between 47 and 65 years of age, and their cases might be complex enough to consider placement, however the decision for placement would not be as easy as that for the seniors group. And the decision making process could take longer due to larger uncertainty.
- b) In comparison to none-seniors, many of the seniors get admitted to the hospital from a LTC facility or already have support services at home with CCAC, and their application process takes less time than new younger candidates.

Both the linear and logistics models explained 23% and about 41% (respectively) of the variability in high or low ALC days and the possibility of waiting ALC or not. What remain needs to be answered by accessing other factors external to the gender, age, unit specialty and type of continuity of care institution. Since waiting no ALC days indicates the absence of a problem, then the focus should be directed towards the characteristics more likely to cause ALC days, and the ones that cause higher ALC days than others.

Long term Care facilities and complex continuing care facilities cause more persistent ALC cases and longer ALC days. This might lead to the conclusion that the hospital cannot do anything about it. Not that it can solve the problem completely, it can either look into what it can do to minimize that delay, or look into quantifying that delay accurately to help with the discharge predictions, and hence help the admission process synchronize incoming cases.

The case of ALC patients going to long term care was used to see whether in fact there is something that the hospital can do to minimize LOS or not. The simulation model that resembled the reality of the situation was compared against one that proposed that the time of admission to referral to social work and the time for involvement of social work be strictly set to a maximum of 3 and 2 days respectively. The improvement was evident with a median decrease of about 5 days (from 35 to 30 days) in length of stay of patients who wait ALC days.

The Red-Yellow-Green light initiative was tested to show a significant improvement of 3 days (from median of 5 to 2 days) for all patients. Perhaps the main reason for this improvement is in the increased number of 'no ALC' patients after the initiative. Therefore, the combined effect of both, the consistent time of discharge activities and the benefits that the RYG light initiative bring would significantly improve the patient flow.

For most of the conclusions made, it should be noted that the data used throughout the course of the project was readily provided by the hospital. The accuracy of the data collection depends on many aspects that this project did not have control over. Since the

variability in most of the variables examined was high, large sample sizes were required to provide meaningful results, therefore the project relied on historical data.

The recommendations that came as a result of this research include:

- a) Immediately involving social workers for senior (age = 65+) patients being admitted to the general medical, renal, and neurology units without necessarily completing any functional assessments for them, as they are very likely to need the involvement of social work. Many functional and social assessments will be done by the social work department and CCAC at a later stage anyway.
- b) Emphasizing the need to start with early discharge planning for all patients as soon as possible. When immediate response is not possible, the cases should be prioritized according to the 'severity of the case' in terms of discharge, just as the triage process in the ED takes care of worst illnesses first. Prioritizing and standardizing the way of getting involved with certain cases can bring the ALC days closer among patients and hence help reduce the spread (variation in ALC days).
- c) Emphasize the importance of getting the patient on the waiting list of the chosen facilities as early as possible. The interval that comes after that is an application processing time. Starting the application earlier - generally speaking- should mean an earlier discharge.
- d) Use the linear regression model to predict the length of ALC days that a given patient will possibly wait, add that to the expected acute care length of stay (as this should be relatively easier to measure by experienced healthcare professionals), and then report the sum as the expected length of stay ELOS. If the

patient is likely to wait long ALC days and their expected acute length of stay is relatively short, then social work should give them higher priority to solve their case. Literature has proven that there is great incomprehensible variety in the metrics among the different provinces. Since the ELOS is generated using values from their database, then the detected deviation from actual is normal for this particular hospital.

- e) Encouraging the accurate and consistent application of RYG light initiative by nurses and physicians since it helps reduce ALC cases. This reduction mainly targets the median of ALC days. Although it should be a very powerful tool in helping the predictions of daily discharge (since the yellow and green status should give an excellent idea about the day to day discharge census), however, the daily accuracy of predictions is still low. Therefore, a better implementation of the initiative by physicians' compliance might help improve the performance.

Some more ideas can be considered as significant recommendations, however, they need to be backed up by further data collection and examination. Some of those future recommendations include:

- f) Encouraging the usage of the destinations flow chart, and destination criteria matrix whenever misunderstandings and lack of agreement is persistent with certain patients requiring placement.
- g) Since the linear model only explains a portion of the variation in ALC days, it is recommended to ask the community care access center for a predicted wait time to get a more accurate ELOS.

- h) Report the approximate number of patients that the hospital sends to each facility so that they will also have a better idea in predicting their admissions and finding ways to accommodate them better.

CHAPTER 7: CONTRIBUTIONS AND FUTURE WORK

It was stated in recent literature from the most involved institutions such as CIHI that there is a struggle in understanding ALC days across Canada. This research proposes a list of approaches that helped in comprehending some of the variability in ALC data and which people are more likely to contribute to this phenomenon. It confirmed that the reasons for ALC are mainly due to placement issues. It also offered an important recommendation of using the likelihood of awaiting ALC days as one of the factors for involving social work, alongside the already existing recognized factors from demographics to dependencies in activities of daily living.

The contributions to the hospital were substantial in that a thorough quantification of its discharge process performance was accomplished. The information that is already recognized by the hospital regarding the several discharge process activities was taken to unravel greater details and connections that were not known before. This was mainly accomplished through the application of proper statistical tools. The discharge process structure was identified and mapped to represent the path that most patients go through. A simulation model was developed to reveal process areas that can be improved.

As for proposed future work, it would be worth to revise the following:

- a) Creating a more detailed simulation model that explores more what-if scenarios which would help develop more recommendations for improvement.

- b) Conducting a feasibility analysis to test the effect of increasing CCAC resources or number of continuity of care facilities on ALC days. Instead of spending budgets on ALC days in hospitals, more can be invested in long term care centers, rehabilitation centers or nurses sent for home support.
- c) This topic is very wide when keeping the scope within the boundaries of the hospital; it would be useful to expand it to include the continuing care facilities as well. Since a significant portion of the variety of ALC days lies in factors not considered by this research effort, it is encouraged to explore more factors from within the hospital and the receiving facilities to explain more of that variation.
- d) Looking into detecting other reasons for ALC days besides the ones that are currently being reported as awaiting placement in another facility. It is very likely that some ALC days are spent due to reasons that the care givers are not ready to accommodate the patient's needs at home among others.
- e) Looking into eliminating the double processing that occurs in the multiple assessments done to the patient in discharge planning that give approximately the same outcomes and conclusions.
- f) In terms of the RYG light initiative, it would be worth conducting a qualitative analysis using quality function deployment (QFD), to unravel the contribution of the initiative's characteristics for the different functional requirements of the discharge planning process.
- g) Looking into collecting information about inpatient's illness severity, such as the APACHE score, and check whether it correlates with ALC days and any other parameters that affect patient flow.

- h) Working closely with the social work department alongside the nurses and unit managers to explore the dynamics of the process from their standpoint and consider factors that they might suggest to get a more accurate examination of the patient flow.

REFERENCES

1. Storch, J., "Country Profile: Canada's Health Care System", Nursing Ethics, Vol. 12: No. 4, 2005, pp. 414-418
2. Pearson, P., Procter, S., Wilcocksonk, J., Allgar, V., "The Process of Hospital Discharge for Medical Patients: A Model", Journal of Advanced Nursing, Vol. 46, No. 5, 2004, pp. 496-505.
3. Health Canada, "Canada's Health Care System (Medicare)", Available at <http://www.hc-sc.gc.ca/hcs-sss/medi-assur/index-eng.php>, 2004 [Accessed 15 March 2009].
4. Health Canada, "Canada's Health Care System", Available at <http://www.hc-sc.gc.ca/hcs-sss/pubs/system-regime/2005-hcs-sss/index-eng.php>, 2005 [Accessed March 16].
5. Sanmartin, C., Shortt, S., Barer, M., Sheps, S., Lewis, S., McDonald, P., "Waiting for Medical Services in Canada: Lots of Heat but Little Light", Vol. 162, Issue 9, 2000, pp. 1305-1310.
6. Procter, P., Compton, WD., Grossman, J., Fanjiang, G., "Building a Better Delivery System: A New Engineering/Health Care Partnership", National Academies, 2005.
7. Kerzner, H., "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", Eighth Edition, United States, 2003.
8. Munro, B., "Statistical Methods for Health Care Research", 5th Edition, Lippincott Williams and Wilkins, United States, 2005.
9. Liker, J., "The Toyota Way", McGraw Hill, United States, NY, 2004.
10. Health Law Professional Series, "2004 Medicare Explained", Commerce Clearing House, United States, 2004.
11. McGinley, S., Baus, E., Gyza, K., "Multidisciplinary Discharge Planning Developing Process", Nurse Management, Vol.10, Issue 27, 1996, pp. 55-60.
12. Hotel Dieu Grace Hospital, "About Hotel Dieu Grace Hospital", Available at <http://www.hdgh.org/Aboutus/ourrole.asp>, 2008 [Accessed on 2 April 2009].

13. Hotel Dieu Grace Hospital, "Facts & Stats", Available at http://www.hdgh.org/Aboutus/facts_stats.asp, [Accessed 2 April 2009].
14. Hotel Dieu Grace Hospital, "Transformation Plan of Care (TPOC)", Available at <http://www.hdgh.org/Aboutus/LEANProcess.asp>, [Accessed 2 April 2009].
15. Hotel Dieu Grace Hospital, "Current State", Available at http://www.hdgh.org/Aboutus/strategic_planning.asp, 2008 [Accessed 3 April 2009].
16. Hotel Dieu Grace Hospital, "Strategic Priorities and Goals", Available at http://www.hdgh.org/Aboutus/strategic_planning.asp, 2008 [Accessed 3 April].
17. Mukotekwa, C., Carson, E., "Improving the Discharge Planning Process: A Systems Study", *Journal of Research in Nursing*, Vol.12, Issue 6, 2007, pp. 667-686.
18. Rorden, J., Taft, E., "Discharge Planning Guide for Nurses", W.B. Saunders, United States, 1990.
19. Selker, H., Benshansky, J., Pauker, S., Kassirer J., "The Epidemiology of Delays in a Teaching Hospital: The Development and Use of a Tool That Detects Unnecessary Hospital Days", *Medical Care*, Vol. 27, No. 2, 1989, pp. 112-129.
20. Flanagan, S., Kiesbo, A., "Concurring Capacity", *Healthcare Financial Management*, Vol. 50, No.7, 2004, pp. 92-96.
21. Proudlove, N., Boaden, R., Jorgensen, J., "Developing Bed Managers: the Why and the How", *Journal of Nursing Management*, Vol.15, Issue 1, pp. 34-42.
22. Viall, C., "Patient Throughput: New Terminology, Same Problem", *Nurse Leader*, Vol.3, Issue 3, 2005, pp. 56-58.
23. Gilligan, S., Walters, M., "Quality Improvements in Hospital Flow May Lead to a Reduction in Mortality", *Clinical Governance: An International Journal*, Vol. 13, Issue 1, 2008, pp. 26-34.
24. Thuemmler, C., Morris, C., "Real Time Monitoring of Patient Flow as an Instrument to Optimize Quality of Care in Acute Receiving Units", *Lippinrotts Case Management*, Vol. 10, Issue 5, 2005, pp. 254-260.
25. Lattimer, V., Brailsford, S., Turnbull, J., Tarnaras, P., Smith, H., George, S., Gerard, K., Mastin-Prothero, S., "Reviewing Emergency Care System I: Insights From System Dynamics Modelling", *EmergMed*, Vol. 21, Issue 6, 2004, pp. 686-691.

26. McKenna, H., Keeney, S., Glenn, A., Gordon, P., "Discharge Planning: An Exploratory Study", *Journal of Clinical Nursing*, Vol. 9, No. 4, 2000, pp. 594-601.
27. Evans, R., Hendricks, R., "Evaluating Hospital Discharge Planning: A Randomized Clinical Trial", *Medical Care*, Vol. 31, No. 4, 1993, pp. 358-370.
28. Duffin, C., "Early Discharge Fuels A&E Visits", *Nursing Older People*, Vol. 20, No. 10, 2008, pp. 8-10.
29. Hou, J., Hollenburg, J., Charlson, M., "Can Physicians' Admission Evaluation of Patients' Status Help to Identify Patients Requiring Social Work Interventions?", *Social Work in Health Care*, Vol. 33, Issue 2, 2001, pp.17-27.
30. Bull, M., "A Discharge Planning Questionnaire for Clinical Practice", *Applied Nursing Research*, Vol. 7, No. 4, 1994, pp. 193-199.
31. Rosswurm, M., Lanham, D., "Discharge Planning for Elderly Patients", *Journal of Gerontological Nursing*, Vol. 24, Issue 5, 1998, pp. 14-21.
32. Rothwell, T., "Integrated Working Puts Discharge Delays to Bed at the Countess of Chester Hospital", *The British Journal of Healthcare Computing and Information Management*, Vol. 24, No. 2, 2007, pp. 18-20.
33. Department of Health, "Hospital Discharge Workbook: A Manual Hospital Discharge Practice. London", Department of Health, 1994.
34. Department of Health, "National Services Framework for Older People", Crown, United Kingdom, 2001.
35. Department of Health, "Discharge from Hospital: Pathway, Process and Practice". Department of Health, London, 2003.
36. H.M.Government "Community Care (Delayed Discharges etc.) Act", H.M.S.O, London, 2003.
37. The ALC Expert Panel "Appropriate Level of Care: A Patient Flow, System Integration and Capacity Solution". December, 2006.
38. Canadian Institute for Health Information, "Alternate Level of Care in Canada", Canada, 2009.
39. Finger Lakes Health Systems Agency, "Non-acute Patients in Acute Care Beds". New York, 2005.

40. Kujala, J., Lilrank, P., Kronstorm, V., Peltokorpi, A., "Time Based Management of Patient Processes", *Journal of Health Organization and Management*, Vol. 20, No., 6, 2006, pp. 512-524.
41. Karr, V. (1997), "'Episode of Care' Approach Fine Tunes Case Management", *Employee Benefit Plan Review*, Vol. 52 No. 5, pp. 46-7.
42. Chang, C., Cheng, B., "To Establish a Continuity Care System of Discharge Planning by QFD", *TQM & Business Excellence*, Vol. 14, No. 8, 2003, pp. 903-918.
43. Holtby, M., "Know How it Works Before You Fix It: A Data Analysis Strategy from an Inpatient Nephrology Patient Flow Improvement Project", *The CANNT Journal*, Vol.17, Issue 1, 2007, pp. 30-36.
44. Institute of Healthcare Improvement, "How to improve improvement methods", Available at <http://ihi.org/IHI/Topics/Improvement/ImprovementMethods/HowToImprove>, 2006.
45. Hartigan, E., Brow, D., "Discharge Planning for Continuity of Care", Revised Edition, National League for Nursing, United States, NY, 1985.
46. Hospital Case Management, "Patient Flow Initiative Reduces Hours on Hold, Decreases Length of Stay", *Hospital Case Management*, Vol. 16, Issue 11, 2008, pp. 167-168.
47. Knaus, A., Zimmerman, E., Wagner, D., Draper, E., Lawrence, D., "APACHE-Acute Physiology and Chronic Health Evaluation: A Physiologically Based Classification System", *Critical Care Medicine*, Vol. 9, 1981, pp. 591-597.

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